UNIVERSITY OF MICHIGAN
MAR 28 1956
ENGINEERING

electronics

McGRAW-HILL PUBLICATION • 75 CENTS

APRIL 1956

TELEMETERING
Electronic Data Transmission

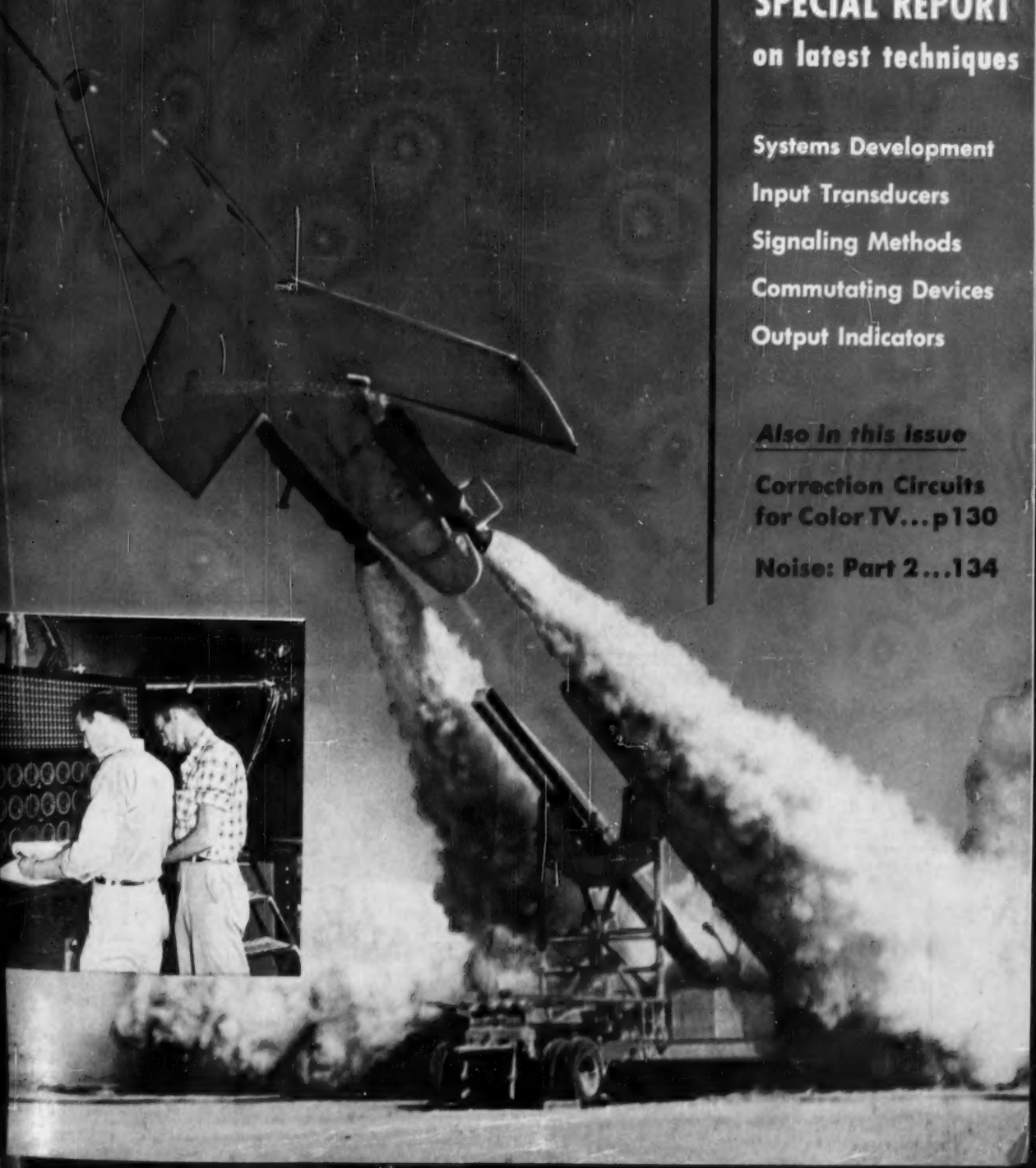
28-page SPECIAL REPORT on latest techniques

- Systems Development
- Input Transducers
- Signaling Methods
- Commutating Devices
- Output Indicators

Also in this issue

Correction Circuits for Color TV...p130

Noise: Part 2...134



LEADERS IN MINIATURIZATION FOR OVER TWENTY YEARS...

MINIATURIZED TRANSFORMER COMPONENTS

Items below and 650 others in our catalog A.

HERMETIC SUB-MINIATURE AUDIO UNITS

These are the smallest hermetic audios made.

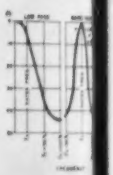
Dimensions . . . 1/2 x 11/16 x 29/32 . . . Weight.8 oz.

TYPICAL ITEMS

Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri MA	Response ±2 db (Cyc.)	Max. level dbm
H-30	Input to grid	TF1A10YY	50*	62,500	0	150-10,000	+13
H-31	Single plate to single grid, 3:1	TF1A15YY	10,000	90,000	0	300-10,000	+13
H-32	Single plate to line	TF1A13YY	10,000*	200	3	300-10,000	+13
H-33	Single plate to low impedance	TF1A13YY	30,000	50	1	300-10,000	+15
H-34	Single plate to low impedance	TF1A13YY	100,000	60	.5	300-10,000	+ 6
H-35	Reactor	TF1A20YY	100 Henries-0 DC, 50 Henries-1 Ma. DC, 4,400 ohms.				
H-36	Transistor Interstage	TF1A15YY	25,000	1,000	.5	300-10,000	+10

*Can be used with higher source impedances, with corresponding reduction in frequency range and current

COMPACT HERMETIC AUDIO FILTERS



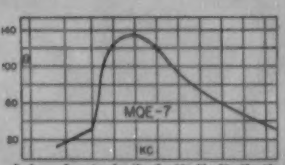
UTC standardized filters are for low pass, high pass, and band pass application in both interstage and line impedance designs. Thirty four stock values, others to order. Case 1-3/16 x 1-11/16 x 1-5/8 — 2-1/2 high . . . Weight 6-9 oz.

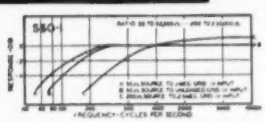
HERMETIC MINIATURE HI-Q TOROIDS

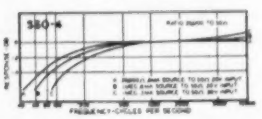
MQE units provide high Q, excellent stability and minimum hum pickup in a case only. 1/2 x 1-1/16 x 17/32 . . . weight 1.5 oz.

TYPICAL ITEMS

Type No.	Inductance	DC Max.
MQE-1	7 mhy.	135
MQE-3	20 mhy.	80
MQE-5	50 mhy.	50
MQE-7	100 mhy.	35
MQE-10	.4 hy.	17
MQE-12	.9 hy.	12
MQE-15	2.8 hy.	7.2







SUB-SUBOUNCER AUDIO UNITS

UTC Subouncer and sub-subouncer units provide exceptional efficiency and frequency range in small size. Constructional details assure maximum stability. SSO units are 7/16 x 3/4 x 43/64 . . . 1/50 lb.

Type	Application	Level	Pri. Imp.	MA D.C. in Pri.	Sec. Imp.	Pri. Res.
*SSO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	13.5
SSO-2	Interstage /3:1	+ 4 V.U.	10,000	0-.25	90,000	750
*SSO-3	Plate to Line	+20 V.U.	10,000 25,000	3 1.5	200 500	2600
SSO-4	Output	+20 V.U.	30,000	1.0	50	2875
SSO-5	Reactor 50 HY at 1 mil. D.C. 4400 ohms D.C. Res.					
SSO-6	Output	+20 V.U.	100,000	.5	60	4700
*SSO-7	Transistor Interstage	+10 V.U.	20,000 30,000	.5 .5	800 1,200	850

* Impedance ratio is fixed, 1250:1 for SSO-1, 1:50 for SSO-3. Any impedance between the values shown may be employed.

OUNCER (WIDE RANGE) AUDIO UNITS

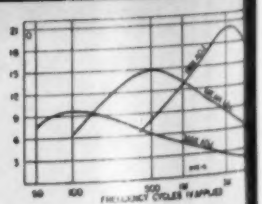
Standard for the industry for 15 yrs., these units provide 30-20,000 cycle response in a case 7/8 dia. x 1-3/16 high. Weight 1 oz.

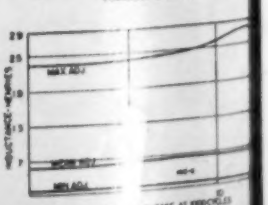
TYPICAL ITEMS

Type No.	Application	Pri. Imp	Sec. Imp
O-1	Mike, pickup or line to 1 grid	50, 200/250, 500/600	50,000
O-4	Single plate to 1 grid	15,000	60,000
O-7	Single plate to 2 grids, D.C. in Pri.	15,000	95,000
O-9	Single plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600
O-10	Push pull plates to line	30,000 ohms plate to plate	50, 200/250, 500/600
O-12	Mixing and matching	50, 200/250	50, 200/250, 500/600
O-13	Reactor, 300 Hys.—no D.C.;	50 Hys.—3 MA. D.C., 6000 ohms	

HERMETIC VARIABLE INDUCTORS

These inductors provide high Q from 50 - 10,000 cycles with exceptional stability. Wide inductance range (10 - 1) in an extremely compact case 25/32 x 1-1/8 x 1-3/16 . . . Weight 2 oz.





TYPICAL ITEMS

TYPE No.	Min. Hys.	Mean Hys.	Max. Hys.	DC Ma
HVC-1	.002	.006	.02	100
HVC-3	.011	.040	.11	40
HVC-5	.07	.25	.7	20
HVC-6	.2	.6	2	15
HVC-10	7.0	25	70	3.5
HVC-12	50	150	500	1.5

LET US MINIATURIZE YOUR GEAR.

UNITED TRANSFOR ER C

150 Varick Street, New York 13, N. Y. • EXPORT DIVISION: 13 E St., New York

CABLES: "ARLAB"

electronics

A McGRAW-HILL PUBLICATION

APRIL • 1956

GUIDED MISSILE TAKES OFF—Regulus, built by Chance-Vought for Navy, launched on test at Point Mugu in California, is controlled by electronic equipment shown in insert (see p 154) ..... COVER

H. W. MATEER, *Publisher*

W. W. MacDONALD, *Editor*
VIN ZELUFF, *Managing Editor*
JOHN MARKUS, *Associate Editor*
ALEXANDER A. McKENZIE, *Associate Editor*
JOHN M. CARROLL, *Associate Editor*
WILLIAM P. O'BRIEN, *Assistant Editor*
WILLIAM G. ARNOLD, *Assistant Editor*
DAVID A. FINDLAY, *Assistant Editor*
HAIG A. MANOOGIAN, *Assistant Editor*
GLORIA J. FILIPPONE, *Editorial Assistant*
ARLENE SCHILP, *Editorial Assistant*
CAROLE A. MORRIS, *Editorial Assistant*
GLADYS T. MONTGOMERY, *Washington Editor*
HARRY PHILLIPS, *Art Director*

WALLACE B. BLOOD, *Manager*
R. S. QUINT, *Buyers' Guide Manager*
FRANK H. WARD, *Business Manager*
GEORGE E. POMEROY, *Classified Manager*
DONALD H. MILLER, *New York*
JAMES GIRDWOOD, *New York*
THOMAS B. VOUGHT, *New York*
WM. S. HODGKINSON, *New England*
JAMES T. HAUPTLI, *Philadelphia*
CHARLES WARDNER, *Chicago*
BRUCE WINNER, *Chicago*
WALTER M. LUCE, *Chicago*
HENRY M. SHAW, *Cleveland*
T. H. CARMODY, *San Francisco*
R. C. ALCORN, *San Francisco*
CARL W. DYSINGER, *Los Angeles*
WILLIAM KEARNS, *Atlanta*
GORDON L. JONES, *Dallas*
DOUGLAS BILLIAN, *Dallas*
HERBERT LAGLER, *London*

KEITH HENNEY, *Consultant*

SHOPTALK 2

FIGURES OF THE MONTH 6

INDUSTRY REPORT 7

Designers Deal Tubes Out 7
Transistor Shipments Rise 7
Low-Power TV Gains Ground 8
Salaries Rise With Experience 10
Synthetic Quartz On Market 10
Radar Boosts Missile Work 12
Military TV Gets Off Ground 14
Businessmen Appraise Computers 14
Radio Detects Interference 16
Diode Registrations Rise 16
Dielectric Heating Up-Swing 16
Electronics In Graphic Arts 20
New Business Computer Appears 22
Silicon Sources To Increase 22
Electronics Aids Mechanics 24
TV Screen Sizes Shrink 24
Banks Use Facsimile Link 24
TV Sets In Use Increase 26
Future Meetings 26
Industry Shorts 26

CROSSTALK 121

FEATURES

New Applications for Beam Switching Tubes 122
By John Bethke

Vibration Meter Uses Transistors 127
By John F. Kinkel and M. Carr Wilson

Correction Circuits for Color TV Transmitters 130
By K. E. Mullenger and R. H. McMann, Jr.

Equipment for Generating Noise—Part II 134
By W. R. Bennett

Radar AFC System Uses Mechanical Tuning 138
By John L. Confalone and William R. Rambo

Testing Hardness with Flux Gate Magnetometer 142
By J. P. Isaacs and Geoffrey Grey

Using Traveling-Wave Tubes 144
By Roger E. White

CONTINUED ON NEXT PAGE

contents

continued

Signal-Triggered Sweep Magnifies Pulse Widths 146
By Rudolph L. Kuehn

Permanent-Writing Cathode-Ray Recorder 148
By L. N. Heynick, R. J. Wohl and D. H. Andrews

Balanced-Capacitance Fence Alarm System 150
By Glenn H. Browning

TELEMETERING—Electronic Data Transmission 153
By Alexander A. McKenzie and Haig A. Manoogian

Storage-Tube Device Simulates Radar Net 181
By Saul Shenfeld and Manuel Finkle

Power Transformer Design Charts 184
By Reuben Lee and N. E. Mullinix

ELECTRONS AT WORK 188

Transistor Receiver Powered By Sun..188
Army's First Semiconductor Gear..188
Brane Guides Bomber..188
Infrared Oil-Film Camera..190
Lenticular Film For Color Kines..190
Gunfire Control Tracks Jets..190
Low Capacitance Probe For Video..194
By Howard L. Roberts
Reconnaissance TV..202
Tube Interchangeability..204
Hurricane Prediction..204
Power Tube Assembly..204
Mobile Tower For TV Remotes..206
By Joseph Mitchell
Scenioscope TV Tube..210
Transistor Two-Way Portable..210
Phonetic Alphabet Changes..214
Tube Information Service..214
Microammeter Measures Frequency..216
Plate Photocontrol..216
F-M Transistor Transmitter..220
Hot Dials..222

PRODUCTION TECHNIQUES 224

Glue-Drying Machine for TV Sets..224
Cutting and Clinching Machine..224
Cabinet-Finishing Techniques..226
Gear-Operated Alignment Setup..228
Square-Corner Conveyor..230
Solenoids Connect Wiring Board..230
Take-Apart Tape Spools..232
Plug-Assembly Conveyor..236
Etched Wiring Board Resistivity..238
By L. J. Martin and M. J. Vavra
Short-Run Cable Machine..240
Mounting Etched Wiring Boards..242
Changing Insertion Heads..244
Checking Resistor Cards..246
Cutting and Forming Leads..250
Intensity Markers Aid TV Alignment..254
By L. W. Dixon
Turn-Finding Welder for Pot Taps..258
Connector Assembly Jig..260
Spraying Resistance Cards..264
Horseshoe Bends in Line..264

NEW PRODUCTS 268

LITERATURE 360

PLANTS AND PEOPLE 378

NEW BOOKS 432

THUMBNAIL REVIEWS 442

BACKTALK 444

INDEX TO ADVERTISERS 503

SHOP

▶**NO MOLE HE . . .** The editors frequently travel about New York City, using its famous subway system. Recently our newest staffer, Jack Kinn from New Jersey, ran afoul of the system to the extent that he now carries a subway map. Even so, he still occasionally gets lost.

Analyzing Jack's problem, we find that the train he selects often goes plus or minus 90 degrees from his intended route. We escorted him to the IRE annual meeting, at the Armory in the Bronx and two hotels in Manhattan.

Jack, incidentally, was born in New York City and lived here for 19 years. He just isn't acquainted underground.

▶**POSITIVE FEEDBACK . . .** Every month for the past four years, the Industry Report section of Electronics has carried the statistics of past performance and estimates of the future on the business side of the industry.

The many facets of data on the electronics field, and the details of curves and graphs published, are extremely difficult to remember.

This was brought home last month when a call was made to the research department of a major manufacturer of a certain component. We needed an estimate of annual volume, industrywide, and association and government data did not include that component.

The manufacturer gave us the

electronics

APRIL, 1956 Vol. 29, No. 4

Member ABC and ABP

TALK

figure. Then told us he got it from our Industry Report, published some months earlier.

▸**ELECTRONIC AUTHORING . . .** As most contributing authors have found out, the mechanics of putting a manuscript together varies all over the lot. Raw material such as circuits, graphs and other data may be worked on at the office or lab, at home, or enroute.

At odd times over a period of several months associate editor Carroll collected data for one article. Many of the notes accumulated at home while cleaning out his pockets after visits to engineers using electronics in various industries.

Beleaguered by the mounting pile of old envelopes, billheads and ordinary paper, he dictated his notes into his home recorder. Bit by bit, the tape grew, to a final length of 3,600 feet.

Translation of the information bits to manuscript draft was done at the office. He listened to sections of tape, then dictated text into another machine. Disks from that machine were transcribed to copy by a service department.

The final article, Electronics in the Process Industries, will appear next month.

▸**AUDIO CUTOFF . . .** Man is said to have survived by adapting to his environment. McKenzie and Manoogian turned out the 28-page special report on telemetering, appearing in this issue, by use of survival techniques. One of the techniques they selected has intrigued other members of the editorial staff and may be useful to electronics engineers as well.

DUAL-TRANSDUCER Jack Carroll listens to playback of his rough notes, dictates draft to second recorder from whose disks a stenographer later produced typed sheets of copy for an article

When they began the assignment, reading, studying and writing in the hubbub of a busy editorial office at first seemed impossible. However, they soon acquired several sets of rubber ear plugs and devices for inserting them efficiently. From there on, concentration became simple.

There was one embarrassing interlude when the chief editor suddenly confronted them and began a friendly conversation in his customary gentle tones. Forgetting their ear plugs, the pair wondered for a few moments if he was suffering from a case of severe laryngitis.

What *he* wondered may be cleared up when he reads this.

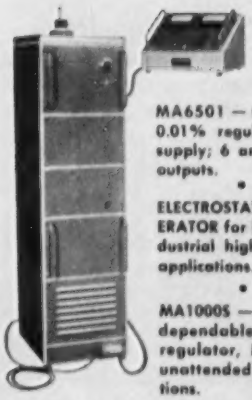
Published monthly with an additional issue in June by McGraw-Hill Publishing Company, Inc., James H. McGraw (1888-1948), Founder. **Executive Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y.** Longacre 4-3000. Publication Office, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Paul Montgomery, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Vice-President and Director of Advertising Sales; J. E. Blackburn, Jr., Vice-President and Circulation Director.

Subscriptions: Address correspondence to Electronics—Subscription Service, 330 W. 42nd St., New York 36, N. Y. Allow one month for change of address. Subscriptions are solicited only from persons engaged in theory, research, design, production, maintenance and use of electronic and industrial control components, parts and products. Position and company connection must be indicated on subscription orders.

Single copies 75¢ for United States and possessions, and Canada; $1.50 for Latin America; $2.00 for all other foreign countries. Buyers' Guide $3.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years. Canada, $10.00 a year; $16.00 for two years. Other western hemisphere countries and the Philippines, $15.00 a year; $25 for two years. All other countries $20.00 a year; $30.00 for two years. Three-year rates, accepted on renewals only, are double the one-year rate. Entered as second-class matter August 29, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U. S. A. Copyright 1956 by McGraw-Hill Publishing Co., Inc.—All Rights Reserved.

BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; McGraw-Hill House, London, E. C. 4; Washington, D. C. 4; Philadelphia 3; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; 1321 Rhodes-Haverty Bldg., Atlanta 3, Ga.; 1125 West Sixth St., Los Angeles 17; 919 Oliver Building, Pittsburgh 22. ELECTRONICS is indexed regularly in The Engineering Index.

MA6501



MA6501 — tubeless 0.01% regulated DC supply; 6 and 2 volt outputs.

•

ELECTROSTATIC GENERATOR for lab or industrial high-voltage applications.

•

MA1000S — tubeless, dependable 1000VA regulator, ideal for unattended installations.

MA1000S

NEW PRODUCTS . . . BROADER ENGINEERING HORIZONS FROM SORENSEN

MR3215 5-32VDC AT 0-15 AMPS
new, tubeless, magnetic amplifier

WIDE RANGE REGULATED DC POWER SUPPLY

for versatile, trouble-free performance in countless design & test applications

Different outside . . . and *inside!* The latest design in magnetic amplifier regulation. A silicon diode is used as reference element and a transistor amplifier provides the control current for the magnetic amplifier. Wide range, continuously adjustable voltage at high current. Regulation ±0.5% against line or load, ripple 1% RMS. Versatile, dependable, rugged, economical.

Write today for detailed specifications, performance data, and quotations.

Sorensen

SORENSEN & COMPANY, 375 FAIRFIELD AVENUE, STAMFORD, CONN.

Mechanical vibration waveforms can now be measured and analyzed with the greatest accuracy, using the revolutionary MUIRHEAD-PAMETRADA Model D-489 Wave Analyzer. Complex vibration waveforms can now be isolated and measured within a wide frequency range, overcoming amplitude and frequency fluctuation and the proximity of component frequencies.

The MUIRHEAD Wave Analyzer operates as a negative feedback, tuned band-pass filter insuring constant selectivity at all frequencies, and simplifying frequency selection. Output voltage is available at tuned frequency for viewing or recording.

This highly versatile instrument has a wide diversity of applications in many industries: aviation, automotive and manufacturing, shipbuilding and electric power generation, to name only a few.

FEATURES

- No internal oscillator—eliminates drift
- R/C-tuned circuits—reduces hum and noise pickup
- Choice of 4 bandwidth characteristics: In-tune High, In-tune Medium, Narrow Band and ⅓ Octave.
- High selectivity characteristic (1% bandwidth for greatest discrimination)
- Auxiliary pre-amp permits use of high-impedance pickups or transducers.

SPECIFICATIONS

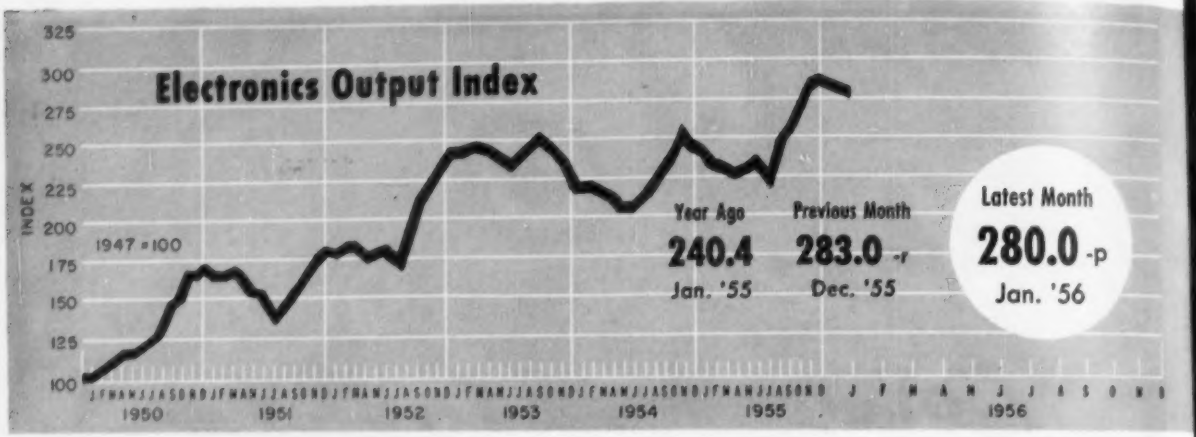
- Frequency range—19 c/s to 21 kc (extendable down to 2 c/s)
- Frequency Stability—± 0.3% over most of range
- Measurement Accuracy— ± 1 db over several days
- Output Voltage—10 v
- Input Voltage—1 mv to 300 v rms (FSD)
- Input Impedance—0.1 megohms
- Hum and Noise Level—Equivalent to .05 mv input at maximum gain
- Power Supply (external)—100/120 v, 60 or 400 cycles, 130 w
- Dimensions—12¾" x 13½" x 17½"
- Weight—55 pounds

Write TODAY for your **FREE** brochure on Vibration Measurement and Waveform Analysis.

MUIRHEAD

MUIRHEAD INSTRUMENTS, Inc. 677 Fifth Ave., New York 22, N.Y.

United States Sales and Service for **MUIRHEAD & CO., LTD.** • **Beckenham** • **Kent** • **England**



FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month	Previous Month	Year Ago
	Jan. '56	Dec. '55	Jan. '55
Television sets, total	588,347	604,626	654,582
With UHF	82,107	89,606	117,095
Color sets	nr	nr	nr
Radio sets, total	1,078,624	1,786,330	1,068,146
With F-M	nr	40,305	16,568
Home sets	nr	396,535	280,121
Clock radios	nr	343,330	166,885
Portable sets	nr	182,204	47,303
Auto sets	519,648	864,261	573,837

RECEIVER SALES

(Source: RETMA)	Jan. '56	Dec. '55	Jan. '55
Television sets, units	614,213	933,467	647,585
Radio sets (except auto)	531,206	1,388,801	474,947

RECEIVING TUBE SALES

(Source: RETMA)	Jan. '56	Dec. '55	Jan. '55
Receiv. tubes, total units	40,141,000	38,049,000	37,951,000
Receiv. tubes, value	$31,314,000	$30,673,000	$26,879,000
Picture tubes, total units	892,385	881,465	866,956
Picture tubes, value	$17,016,391	$17,533,105	$17,661,018

SEMICONDUCTOR SALES ESTIMATES

	Dec. '55	Nov. '55	Dec. '54
Germanium diodes, units Silicon diodes, units	2,690,000	2,575,000-r	1,800,000

INDUSTRIAL TUBE SALES

(Source: NEMA)	Latest Quarter	Previous Quarter	Year Ago
	Quarterly Figures		
	3rd '55	2nd '55	3rd '54
Vacuum (non-receiving)	$9,027,845	$8,933,453	$8,803,740
Gas or vapor	$3,438,835	$3,365,008	$3,570,586
Magnetrons and velocity modulation tubes	$10,998,967	$13,193,395	$13,112,244
Gaps and T/R boxes	$1,421,138	$1,677,574	$1,476,407

BROADCAST STATIONS

(Source: FCC)	Latest Month	Previous Month	Year Ago
	Feb. '56	Jan. '56	Feb. '55
TV stations on air	485	484	448
TV stations CPs—not on air	106	105	130
TV stations—new requests	22	26	17
A-M stations on air	2,841	2,834	2,692
A-M stations CPs—not on air	123	120	101
A-M stations—new requests	247	242	186
F-M stations on air	539	538	542
F-M stations CPs—not on air	13	16	11
F-M stations—new requests	4	3	5

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Jan. '56	Dec. '55	Jan. '55
Aeronautical	44,331	44,836	41,868
Marine	54,276	53,950	48,751
Police, fire, etc.	19,757	19,885	17,148
Industrial	27,599	27,269	23,223
Land transportation	8,576	8,481	7,289
Amateur	143,841	142,819	129,258
Citizens radio	14,920	14,426	9,579
Disaster	326	321	310
Experimental	644	674	649
Common carrier	2,137	2,093	1,810

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Dec. '55	Nov. '55	Dec. '54
Prod. workers, comm. equip.	404.0 -p	406.0 -r	379,000
Av. wkly. earnings, comm.	$75.53-p	$75.53-r	$70.70
Av. wkly. earnings, radio	$71.81-p	$71.81-r	$69.49
Av. wkly. hours, comm.	41.5 -p	41.5	40.4
Av. wkly. hours, radio	40.8 -p	40.8 -r	40.4

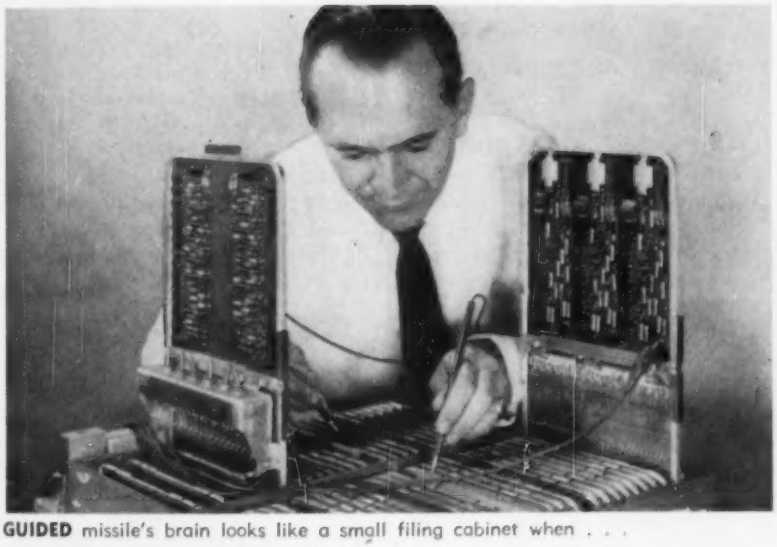
STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Feb. '56	Jan. '56	Feb. '55
Radio-tv & electronics	426.8	435.6	437.0
Radio broadcasters	489.8	500.5	496.8

p—provisional; r—revised
nr—not reported

FIGURES OF THE YEAR

	TOTALS FOR FIRST MONTH 1956	1955	Percent Change	1955 Total
Television set production	588,347	654,582	—10.1	7,756,521
Radio set production	1,078,624	1,068,146	+ 1.0	14,894,695
Television set sales	614,213	647,585	— 5.2	7,421,084
Radio set sales (except auto)	531,206	474,947	+11.8	6,921,384
Receiving tube sales	40,141,000	37,951,000	+ 5.8	479,802,000
Cathode-ray tube sales	892,385	866,956	+ 2.9	10,874,234



GUIDED missile's brain looks like a small filing cabinet when . . .

Designers Deal Tubes Out

Transistors and magnetic amplifiers share spotlight as prime computer elements

"ANY engineer who designs an electron tube into a new computer will have to tell me why." This word went out recently from the chief engineer of a large west coast electronics firm. It typifies contemporary thinking among computer designers.

Engineers look with jaundiced eye on the 4,000-odd electron-tube filaments that must be heated to incandescence when a big brain goes to work. Rusticating the tube would save power and cut down on space requirements. Cooling and air-conditioning problems would likewise evaporate.

▶ **On The Bench** — An attractive alternative to the electron tube is the transistor. An airborne digital computer developed by North American Aviation's missile people uses 1,000 transistors in etched circuits. The three-cubic-foot, 125-lb brain is four times lighter than its electron-tube counterpart. It consumes 100 watts instead of 3,000 for the tube job. The computer can generate continuous solutions for differential and trigonometric problems. It can do 93 integrations at once. General Electric 2N43 transistors are used.

Philco is working on at least three Transacs. Introduced last year, this digital computer uses surface-barrier transistors in direct-coupled circuits. At least one of the units under development is for airborne computing.

IBM has already shown a transistorized electronic calculator, the model 608. This computer is designed for business and industry.

▶ **Dark Horse** — Although most computer designers are fondly eyeing the transistor Sperry Rand is betting on the magnetic amplifier. Magnetic components are not strange to the computer field. Ferrite-core internal memories and tape-wound-core shift registers are extremely important. Word, however, was that magnetic amplifiers were just too slow for high-speed stored-program digital computers.

A break came from Sperry Rand's South Norwalk, Conn. operations in the form of the $12,500 Ferractor magnetic-amplifier computer. However, this unit was still relatively slow.

Then from Philadelphia came the Univac engineering calculator, an all-magnetic computer adapted from a device developed for the Air Force's Cambridge Research Center. This computer uses 1,500 magnetic cores, the magnetic clock drives magnetic amplifiers at 660 kc.

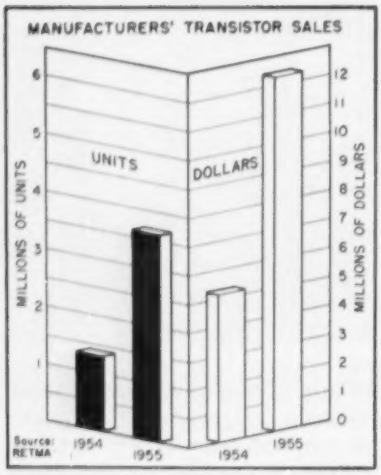
Transistor Shipments In Sharp Rise

Unit shipments tripled during 1955; 400 million sales figure seen for 1965

SNOWBALLING sales by transistor manufacturers reflect their wholehearted acceptance by equipment manufacturers in both entertainment and nonentertainment fields.

Sales for 1955 were 3,646,802 units, almost triple the 1954 figure of 1,317,327. Value in 1955 was $12,252,741 against $5,122,266 for 1954.

The upswing is continuing on a



month-to-month basis. December 1955 sales were 479,968 units at $1,614,805 while for January 1956, 572,674 transistors worth $1,893,250 were sold.

Total transistor sales for 1956 should reach 10 to 11 million units. For 1957 this is expected to double. By 1965 the transistor business should be well established at 400 million annually.

► **Breakdown**—Half of 1956 production will be for entertainment use, largely in portable radios and some auto sets. For the rest: 1.4 million will go into computers and digital devices, 1.3 into communications equipment and 2.8 into other applications, including hearing aids.

The 5.5 million transistors for nonentertainment use will include silicon and military-type units.

► **Applications** — For the short haul, entertainment uses are expected to take a high of 75 percent of production. Contributing factors will be 100-percent transistorization of portable, table and clock radios. Even the clocks may be transistorized. Almost every auto radio will be transistorized. The transistorization of tv sets will probably come about through introduction of transistors first in special circuits, for example, color decoders.

► **Shifting Balance**—For the long haul, the entertainment share may decline to about 66 percent as transistors in computers, industrial-control equipment and communications gear multiply. Transistors are already important in special communications, airborne control and navigation and missile-guidance equipment.

► **Production** — The predicted increase for transistor sales depends entirely on the market. Capacity of manufacturers to produce transistors is more than sufficient to meet the predicted demand. Today, the combined production facilities of three of the larger transistor manufacturers total nearly 1 million units a month. General Electric plans to double its production capacity by the middle of the year.

Low-Power TV Gains Ground

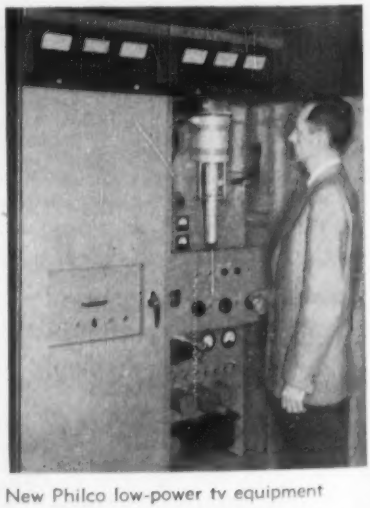
Philco and RCA introduce equipment for the field. Other companies eye the new market

ANOTHER broadcast equipment manufacturer has entered the low-power tv station market created last June when the FCC amended its rules to permit uhf and vhf stations to operate with a minimum visual effective radiated power of minus 10 dbk (decibels below 1 kw or 100 watts) at any antenna height. Philco announced new low-power tv broadcasting packages chiefly for the estimated 800 small communities where tv has been unavailable because of high costs of conventional equipment. RCA is beginning production on a new 100-watt vhf transmitter.

► **Military** — Several broadcast equipment makers have been in the low-power tv field for some time. The equipment gained impetus when the military began establishing low-power tv stations for troops in isolated areas in the U. S. and abroad. There are now some 15 of the military stations in operation. About 75 are possible if all potential areas are equipped. So far, equipment for these stations has been supplied by various manufacturers with Dage and RCA supplying the bulk.

► **Firms**—With Philco's entry into the field and RCA's new equipment, other broadcast equipment manufacturers are watching the field more closely. Du Mont has not yet introduced equipment for low-power use but plans to move into the field if it develops successfully. GE is also watching the field closely but has not as yet announced low-power gear. RCA has had low-power tv station equipment available through its International Division and has equipped one commercial station in Guatemala with an 18-watt transmitter.

► **Stations**—There are no 100-watt commercial tv stations in operation in the U. S. at the present time. Lowest power stations now operating in the U. S., according to FCC,



New Philco low-power tv equipment

are KINY-TV at Juneau, Alaska operating at 263 watts and KSHO-TV at Las Vegas, Nevada which began operating on March 9. Construction permits granted to WJMS-TV at Ironwood, Mich. to operate at 794 watts and KZIT-TV at Santa Fe, N. M. with 490 watts constitute present lowest power permits.

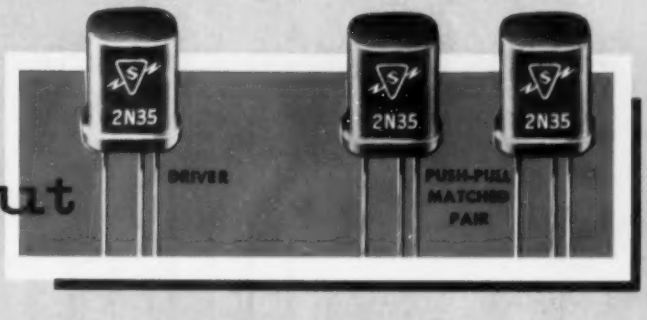
► **Equipment** — The new Philco package includes a transmitter, monitoring equipment, high-gain antenna and transmission line and local program originating facili-

(Continued on page 10)

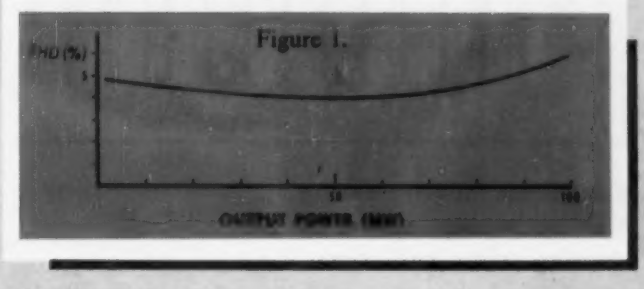
Sylvania NPN transistors

MATCHED

for high audio output



with low distortion



Whatever the front-end design in your transistor audio circuits, Sylvania offers a highly efficient audio transistor line-up for driver and push-pull stages. Controlled driver characteristics and a matched push-pull pair assure maximum power output with minimum distortion.

DRIVER STAGE

Sylvania's 2N35 for Class-A driver use has linear characteristics at high current levels, thereby insuring maximum input to the push-pull stage with minimum distortion.

PUSH-PULL MATCHED PAIR

Output transistors in Sylvania's audio line-up are matched to within 10% on collector current characteristics. The close tolerances to which the 2N35 push-pull pair is produced permit maximum power gain with minimum distortion as plotted in Figure 1.

Power output of the 2N35 pair is rated for a minimum of 100 mw at 50°C. Dissipation is rated at 50 mw, per unit, with higher rated counterparts available.

The all-important facilities — Sylvania is equipped to supply you with production quantities, so why not call your Sylvania Representative for samples. Or write for complete data. Address dept. D20R.

SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., Montreal

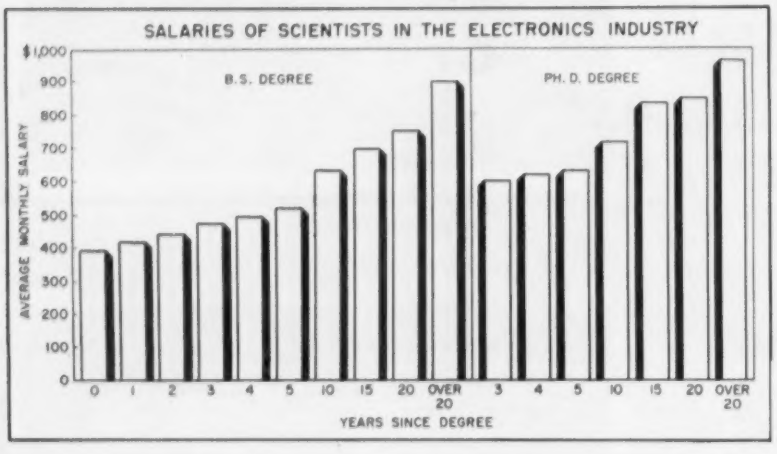
LIGHTING · RADIO · TELEVISION · ELECTRONICS · ATOMIC ENERGY

Want more information? Use post card on last page.

ties for transmission of slides, films and local live shows.

Two types of studio buildings and towers can be included in the packages. The final power amplifier provides 150-watt peak visual power and 75-watt aural power output to the transmission line. The program originating equipment consists of film and live camera chains, video monitoring and switching facilities, and audio facilities. The frequency band used in battlefield surveillance, 470 to 500 mc, can be covered by the transmission equipment.

Salaries Rise With Experience



Electronics industry among the top paying fields both in starting salary and raises

How engineers in the electronics industry fare salarywise as they gain work experience is shown in a national survey by the Los Alamos Laboratory of the University of California of professional scientific salaries in 1954.

The data are based on completed questionnaires submitted by 221 contributors reporting the salaries of more than 50,000 research and development scientists. Administrative and supervisory officials and scientific employees not holding academic degrees are excluded.

Profit sharing plans, production bonuses, cost-of-living allowances and other similar adjustments to base salaries have been added to the reported monthly averages wherever possible. Research and development, as used for the survey, is defined as any activity requiring formal technical training and the exercise of scientific judgment in selecting and applying techniques for the solution of problems related to the improvement of existing products, services or methods and includes pure research.

The engineers classified under B.S. degrees in the chart include those with bachelor's or master's degrees in science or engineering who are engaged in research and development work.

► **Bachelors** — The survey shows that the monthly salaries of engineers with B.S. degrees in the electronics industry are higher at the start than those of engineers in eight other industries. And, although enginers in other industries may move ahead in salary at different times as experience is gained, engineers in the electronics industry with over 20 years experience were also the highest paid of the eight industries surveyed.

Compared to the next three highest paying industries, starting salary of engineers in electronics was $5 higher than in the machinery field, $7 higher than in the petroleum industry and $10 higher than salaries in the aeronautical field. More than 20 years after receiving their B.S. degrees, engineers in electronics were earning $127 more a month than comparable engineers in the aeronautical and petroleum fields and $243 more than engineers in the machinery field.

► **Doctors**—Engineers with Ph.D. degrees in the electronics industry were not as well paid for experience as were engineers in some other industries, according to the survey. Three years after degree, Ph.D.'s in electronics were earning $595 a month and ranked below those in the rubber industry who earned an average monthly salary of $635.

More than 20 years after degree, Ph.D.s in electronics earned $959 per month ranking behind Ph.D.'s in the machinery field earning $1,064 per month and those in the instruments field earning $1,058. In both of these industries, however, the number of Ph.D.'s surveyed or available for survey was small while the number in the electronics industry was among the highest of all industries surveyed.

Synthetic Quartz Now on Open Market

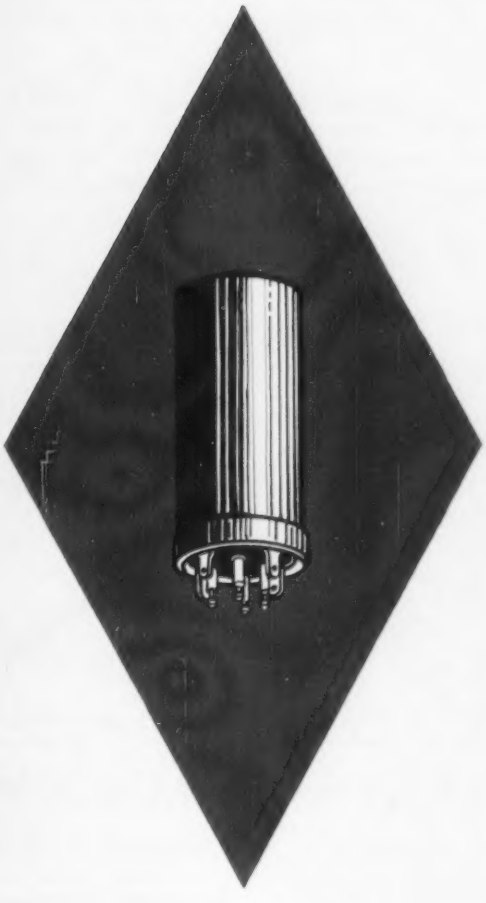
Though priced higher than natural crystals, yield is greater, labor costs lower

AVAILABILITY of synthetic quartz on the open market at $52.50 a pound for the past eight months has resulted in many orders on a sampling basis, but as yet Brazilian natural quartz continues to fill production needs.

Chief reason for slowness of sales is believed to be the need for more time to develop new production techniques that take advantage of the greater perfection of the synthetic crystals. Of the total of over two tons already grown in the pilot plant of Clevite Research Center under Signal Corps contract, about 85 percent has been electronic grade, with this figure approaching 100 percent if experimental runs are neglected.

► **Cost Factors**—Yield per pound is higher because the synthetic is

(Continued on page 12)



EXTENDED LIFE ELECTROLYTIC CAPACITORS

now available for

military electronics
computers
laboratory test instruments
industrial controls
other electronic applications

HERE ARE CAPACITORS OF THE SAME *MAXIMUM RELIABILITY* which Sprague has long supplied to the telephone systems . . . now available for your own high reliability electronic applications.

The use of especially high purity materials . . . utmost care in manufacture, constant observation and quality control of all operations have made Sprague Extended Life Capacitors outstanding for their long life and faultless performance.

Type 17D Extended Life Electrolytics have turret terminals and twist-mounting lugs. A special vent construction is molded right into the cover, as are the numbers identifying each terminal. The aluminum cans are covered with a corrosion-resisting insulating coating.

Nineteen standard ratings, all characterized by low maximum leakage current and remarkable life test capabilities are available in the new series. Complete technical data are in Engineering Bulletin 340, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

SPRAGUE® *world's largest capacitor manufacturer*

Export for the Americas: Sprague Electric International Ltd., North Adams, Massachusetts. CABLE: SPREXINT.

an almost perfect material having few flaws for discard. The synthetic bars are grown to practically the exact cross-section of the resonators being cut, minimizing cutting waste.

The crystals are grown in exactly the desired orientation, so that the cutting saw travels a shorter distance through the material; this permits use of a thinner saw without reducing cutting accuracy, thereby giving more plates per crystal.

Labor costs are reduced because inspection of raw materials for flaws is eliminated, orientation prior to cutting is simplified by the regularity of the grown crystal faces, and the large flat areas simplify cementing operations. Uniform size and shape of the grown crystals also suggests the possibility of mechanizing the entire cutting and finishing operations when producing one size of oscillator plate in high volume.

Where long quartz bars are required, as for low-frequency flexural units, synthetic quartz is actually cheaper on the basis of material cost alone, because of the premium prices on natural quartz long enough to give the required dimensions that are parallel to the Y axis.

Removing batch of half-pound grown quartz crystals from Clevite autoclave. All crystals are essentially identical in shape, weight and orientation

▶ **Future**—A new type of autoclave under consideration is expected to permit a substantial cost reduction in the grown crystals, chiefly through savings in labor for loading and unloading. Expansion of production facilities will follow market demands. None is planned.

Radar Chain Boosts Missile Work

Ten million dollar system will help speed development of intercontinental missiles

FURTHER aid in the current international race to develop an effective intercontinental missile and other supersonic weapons is forthcoming as the world's largest chain radar tracking system nears completion off the coast of Florida.

The system is capable of checking the flight of the newest supersonic rockets and missiles over the full length of the U. S. Air Force Air Research and Development Command's Florida Guided Missile Range. It enables engineers to understand certain problems in aerodynamics that have hampered missile progress.

▶ **Timetable**—The first installation on the Florida Range was made at the test range's central control near Cocoa Beach, Fla. in January of last year. The Grand Bahama station was completed shortly thereafter and other installations followed at the other islands shown on the map. The chain is now complete except for St. Lucia and that installation will be finished early in 1956.

▶ **Equipment** — The radar chain was designed and built by Reeves Instrument Corp., a subsidiary of Dynamics Corp. of America. Value of the job was $10 million.

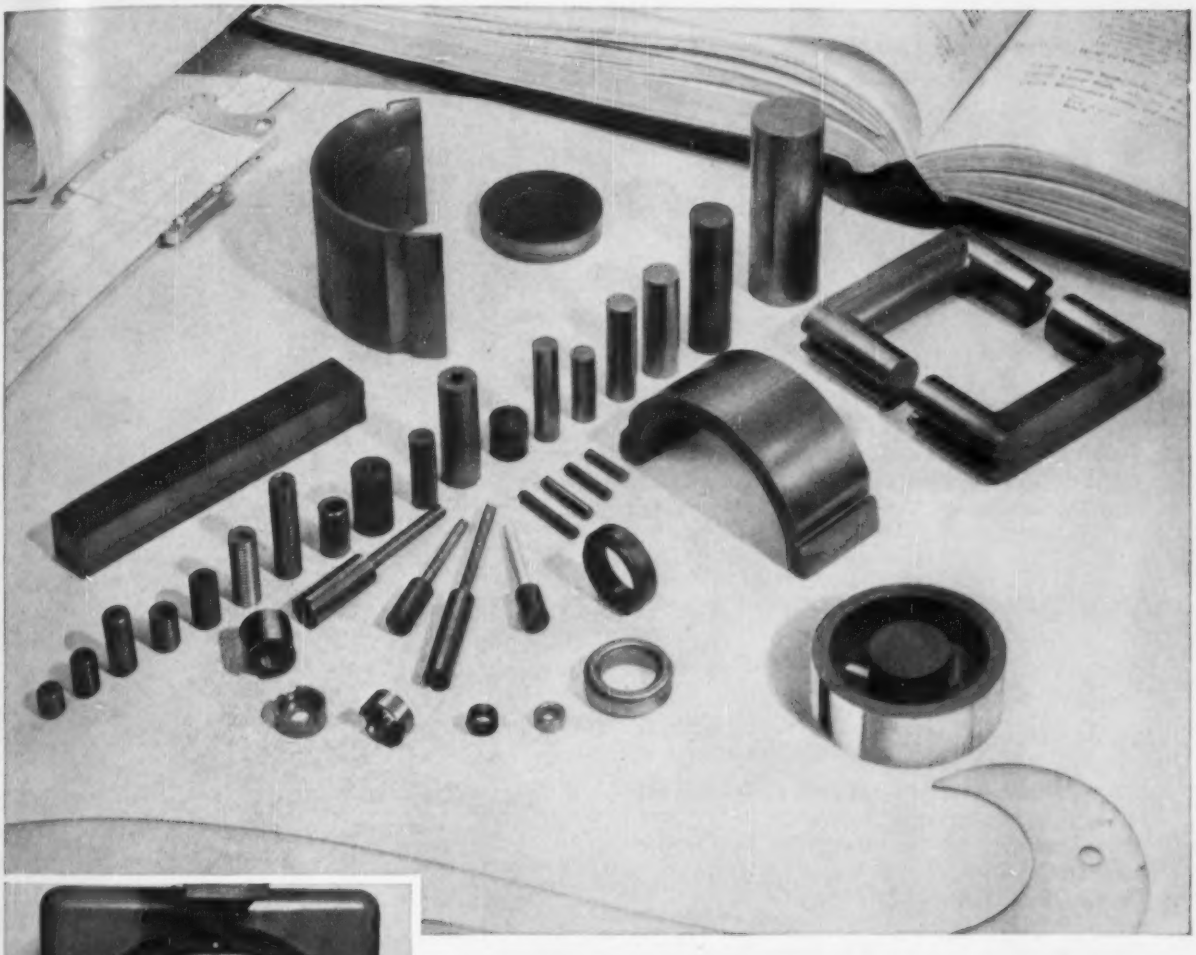
The chain comprises 21 radar installations. Sixteen of the radars are installed in pairs on each of eight islands.

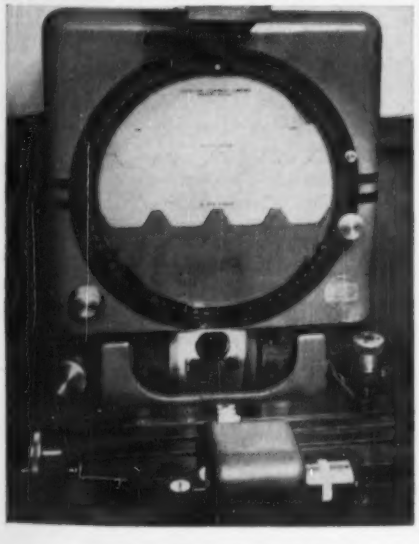
The dual installations provide standby equipment. One installation checks on the other and can take over in case of failure. The island installations are in air-conditioned buildings. The remaining five installations are located in mobile vans.

▶ **Functions** — The five-ton radar systems are almost fully automatic. One operator is required at each installation for missile acquisition. Once the radar locks onto the missile the operation is carried on automatically. The radars record and report back position, course, velocity and acceleration. Accuracy is within 0.02 deg.

Tracking continues to the end of the test run. If the missile deflects from course or becomes erratic, a control to destroy it can be actuated. There have been no accidents from runaway missiles.

(Continued on page 14)





IRON POWDER CORES

to meet your highest requirements

★ *For Quality*

★ *For Dimensional Accuracy*

Here are the essential facts to keep in mind about iron powder cores—and Arnold. As illustrated above, we make a wide selection of cores, from simple cylinders to special cores of complicated design. That includes all standard types and sizes of threaded cores, cup, sleeve, slug and cylindrical insert cores you may require: for use in antenna and RF coils, oscillator coils, IF coils, perm tuning, FM coils, television RF coils, noise filter coils, induction heating and bombarder coils, and other low frequency applications. Also, a standard series of iron powder toroids is being engineered at this time, which will conform to the standard sizes proposed by the Metal Powder Association. • We'll appreciate the opportunity to supply your needs . . . *let us quote on your requirements.*

WSW 6044

COMPARATOR-CHECKED

to insure precision parts

Threaded cores are checked on an optical comparator at 100-x magnification to assure exact conformance. Arnold quality control of iron powder cores includes the maintaining of rigid electrical, physical and dimensional specifications unmatched in the industry.

Write for a copy of Bulletin PC-109

Contains essential data on processing, control methods, applications, types, sizes, suggested use frequencies, etc. of Arnold iron powder cores.

ADDRESS DEPT. E-64

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

Los Angeles: 3450 Wilshire Blvd. Boston: 200 Berkeley St.

APPROACHING aircraft can be watched on one of three control-tower monitors at Alameda Naval Air Station (left). Tactical television camera (right) gives Army more eyes. And new f-m gear will help when . . .

Military Television Gets Off The Ground

New air-surface system supplements existing closed-circuit and walkie types

INCREASED use of television techniques in defense operations is highlighted by three different systems for seeing at a distance. Navy has installed traffic control tv at NAS Alameda; the Signal Corps has developed a walkie-peepie and is testing an f-m airborne reconnaissance link.

► **Airborne Scout**—In contrast to commercial tv broadcasting, Army's new air-ground picture transmitter uses frequency modulation instead of amplitude modulation. Admiral Corporation engineers who built the equipment say that a plane flying at 1,000 feet could send back pictures to a command post receiver 25 or 30 miles away.

Not mentioned, but technically possible would be the relaying of such information through one or more intermediate aircraft to posts 100 or 200 miles distant.

► **Expendable Robot**—For the foot soldier, the Signal Corps has an 8-pound camera that sends out picture signals from a back-pack transmitter weighing 47 pounds with power supply.

A standard hand-held radio transmitter supplies the sound channel. Receiver is normally mounted in a jeep. The camera could be left in a hazardous location, connected by cable with the receiver.

► **Visual Radar**—A closed-circuit system using three cameras, installed by Kay Labs, gives Navy airfield operators at Alameda positive control of runway operations a half mile distant. Intervening buildings formerly blocked the view. Vehicular traffic on the airfield perimeter road that crosses the end of the runway is likewise visible.

Coming of the jet age, with longer runways, presages increased use of similar closed circuits at costs in the order of $50,000 each.

Businessmen Appraise Computers

Uses continue to multiply; several new employment opportunities are created

NEARLY everything from electric bills to Holy Scripture is grist for the electronic computer's mill. Recent months have seen groups such as the American Management Association and the Society of Applied Antropology seriously discussing electronics.

► **Applications**—It has been estimated that a stored-program computer is profitable when it can take over the duties of 90 or more clerks. Users of computers in the life insurance field were numerous at the AMA conference. They included John Hancock with 2 million policies in force; Franklin Life with ½ million policies; and Mutual Life of Los Angeles with 350,000 policies. All these firms have Univacs.

Consolidated Edison of N. Y. will use a Univac for customer accounting and an IBM 705 for payroll and general accounting. Chrysler has an IBM 702 for inventory control in its Parts Division and an IBM 650 doing payroll work at Plymouth. Dodge Truck division expects to have a Univac File Computer.

An unusual application of the Univac was preparing a concordance of the Holy Bible. Over 800,000 words were listed alphabetically with context and indexed by book, chapter and verse.

► **Installation**—Putting in a computer takes, on the average, 9 to 12 months and requires 20 to 35 man-years. At John Hancock, initial studies required 10,000 hours costing $50,000 while Minneapolis-Honeywell reports its study cost $42,000.

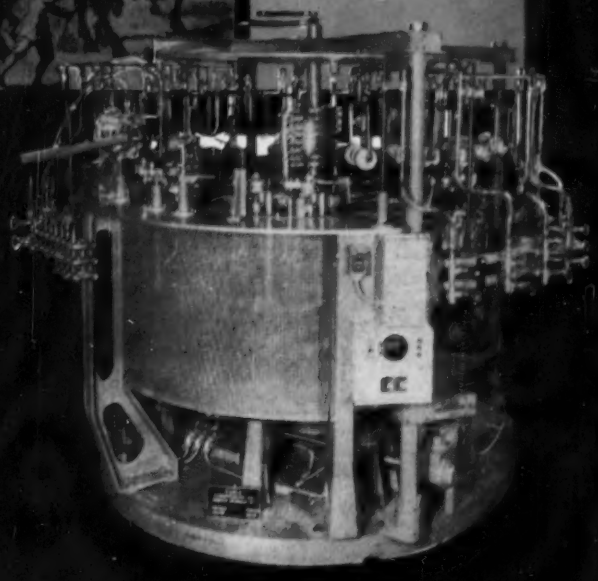
Preparation of the site cost John Hancock $200,000 while overall installation at Franklin Life came to $250,000.

► **Personnel** — An average computer crew has been estimated at

Most

revolutionary development in vacuums.....

SINCE 1650 A. D.



Rotary Exhaust Machine #2624

The Magdeburg Hemispheres Test was the first demonstration of creating a vacuum. That was in 1650 over 300 years ago . . . today Kahle has demonstrated a revolutionary new concept in vacuum . . . a valve-less *rotary Exhaust Machine*.

This rapid-speed, rotary-in-line, automatic *Exhaust Machine* features a *continuous all-metal vacuum path from port through diffusion pump* . . . completely eliminates the conventional slide valve . . . individual automatic leak detector and shut-off valve on each port . . . water cooled compression chucks are automatically operated . . . automatic tipping torch and automatic tubulation remover are also employed.

Ultra-high vacuum is achieved with the unique design and rugged construction of Kahle's automatic *Exhaust Machine*. Ideal for exhausting cathode ray tubes, transmitting tubes, receiving tubes, x-ray tubes, and *all* other high-reliability types.

The type *Machine* illustrated is one of a wide selection of sizes and ranges available at Kahle.

Write today for valuable File Folder containing complete specifications and information.

Kahle

ENGINEERING COMPANY 1310 SEVENTH STREET NORTH BERGEN, N. J.

DESIGNERS AND BUILDERS OF AUTOMATIC AND SEMI-AUTOMATIC EQUIPMENT FOR ALL INDUSTRIAL OPERATIONS

17 men. John Hancock's team numbers 19. Franklin Life estimates a 70-man staff including clerks and typists for a 7-day 24-hour operation.

Although some manufacturers recommend only 1 or 2 mathematicians and engineers, Franklin Life, which does its own maintenance, employs a chief engineer and senior engineer, both with previous computer experience, 2 junior engineers and 4 technicians. Franklin has 10 programmers but feels the company should have set its sights on 20 to 25.

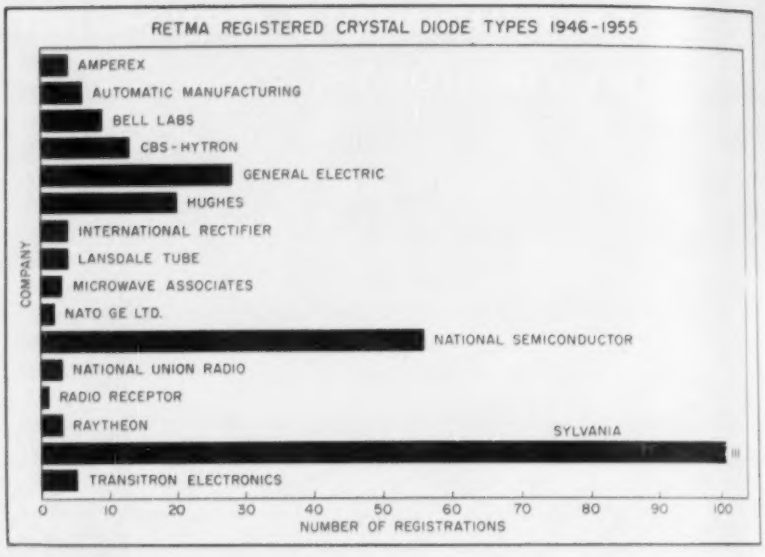
For all-week round-the-clock operation, Franklin estimates need for 25 clerical coders, 15 engineers, technicians, operators and tape handlers, 20 typists and 10 programmers.

► **Outlook**—One major change that computers may cause is shift work for white collar workers. Another is creation of a new profession, the information engineer, as programmers have been called. They organize the sequence of control of information and understand operation of the machine. Within the next decade 17,000 programmers may be needed.

This new group is already in short supply. As a consequence, they are well paid and turnover is high in some installations.

Transistorized Radio Detects Interference

Exploring trouble sources in electrical equipment is a new use for pocket-sized transistor radios, according to Raytheon



Crystal Diode Registrations Rise

Over 270 types have been registered with JETEC since 1946

GROWING use of crystal diodes in electronic equipment is indicated by the growing number of types registered by manufacturers. Although registrations do not always mean that production of the device is underway, it usually indicates that the type has reached production level either by the company that sponsored its development or by licensees of the device.

► **Progress** — According to the Joint Electron Tube Engineering Council's summary of registered crystal diodes, in 1955 some 107 types were registered representing nearly 40 percent of total diode registrations since 1946. In 1954, 65 types were registered and in 1953 the total was 43. Until 1953 the number of diode registrations ranged between 2 and 20 each year for an annual average of 8 registrations.

► **Makers** — Some 16 electronics manufacturers have been active in the development of crystal diodes since 1946. Sylvania has been the leading sponsor of the devices, according to registration records, with about twice as many registered as any other company.

► **Material** — Silicon diodes have forged ahead in number of registrations. Of the more than 272 types that have been registered since 1946, some 57 percent have been silicon types. In 1955 only 15 of the 107 total registered were germanium types. The remainder were silicon diodes.

► **Use** — Although full details on the use for each type of diode registered is not given in the summary report, it shows that about 60 of the types were for general purposes. Four types were specifically indicated for use in computers, two for tv and six as power rectifiers.

Dielectric Heating On Up-Swing

Sales of sealing units increased by demands of fast-moving plastics industry

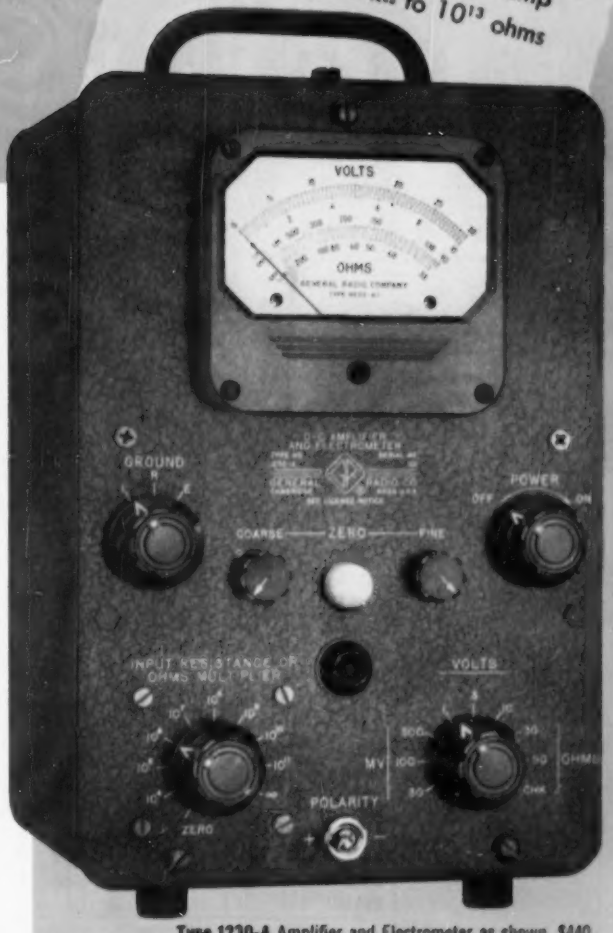
GROWTH in the dielectric heating business is accelerating due to demands for more and varied consumer products made from thermosetting plastics. Such sealing units

(Continued on page 20)

All in One Package!

Millivoltmeter
Micro-microammeter
Mega-megohmmeter

Ranges, Full Scale
Voltage: 30 mv to 10 volts
Current: 1 ma to 3 x 10^{-13} amp
Resistance: 300 kΩ to 10^{13} ohms



Type 1230-A Amplifier and Electrometer as shown, $440.
Type 1230-AE Amplifier and Electrometer in Esterline Angus Cabinet, $502.

The G-R Type 1230-A D-C Amplifier and Electrometer represents a new and important contribution to the field of electrical-measuring equipment.

A *low-cost* instrument of high performance for the measurement of extremely small d-c voltages, currents and charges has not been hitherto available. As if not enough, this device is also a completely self-contained megohmmeter with provision for measuring higher resistances than possible with many instruments specializing in this measurement. Output jacks, at the rear, permit use as a sensitive d-c amplifier to drive 1-ma or 5-ma recording equipment such as the Esterline Angus Recorders. .

Superior performance is obtained through a carefully thought-out design. An electrometer tube is used in the first of three direct-coupled stages to keep grid current effects truly negligible. The stringent stability requirements necessary for an instrument such as this are met through use of excellent supply regulation, insulation of the highest quality, shock mounting, wire-wound resistors at all critical locations, and aging of both tubes and components . . . in short, through adherence to the high standards of engineering and manufacture which have come to be expected of the General Radio Company.

The Type 1230-A Amplifier and Electrometer has many applications in industrial-process control and in physical and chemical research, in addition to its obvious uses in the electronics laboratory. The instrument may be used: to operate from strain gauges; to indicate or record time-current curves of capacitors under charge or discharge; to record life tests on vacuum tubes and other components; to measure semi-conductor resistance, piezo-electric potentials, electrostatic fields, ph indications, contact potentials, grid currents in tubes, and insulation resistance of motors, generators and appliances; and, in general, to measure any physical or chemical reaction where a d-c voltage or current proportional to the change is available.

This instrument is a truly versatile device . . . one we're proud to present, and one every laboratory will want to own.

Six Voltage Ranges: ±30 mv, 100 mv, 300 mv, 1v, 3v, and 10v d-c, full scale — accuracy, 2% of full scale on all five higher ranges, 4% of full scale on lowest 30-mv range.

Twenty Current Ranges: from ±1 ma to ±3 x 10^{-13} amp d-c, full scale — accuracy, 3% of full scale from ±1 ma to ±3 x 10^{-9} amp and 10% to ±3 x 10^{-13} amp.

Sixteen Resistance Ranges: direct reading 300 kΩ to 10 MMΩ, full scale; 5 x 10^{14}Ω at smallest meter division — accuracy, 3% from 3 x 10^{5}Ω to 10^{10}Ω and 8% to 10^{13}Ω — with external 300v batteries in place of the internal 9v source, resistance range can be extended to read 6 x 10^{14}Ω at smallest meter division.

Since resistance is easily measured with different voltages applied to the unit under test, voltage coefficients are readily obtained.

Internal Resistance Standards: 10^{4} and 10^{9} ohm steps accurate to 0.25%; 10^{6}, 10^{7} and 10^{8} ohms accurate to 1%; 10^{9}, 10^{10}, 10^{11} ohms accurate to 5% and have been treated to prevent adverse humidity effects. 0 and ∞ steps also available.

Switch provided for checking higher resistance standards in terms of more precise 10^{4} and 10^{9} ohm wire-wound units (makes possible working back to high basic accuracy over the complete range).

High Input Resistance: determined by setting of resistance standards switch; 10^{14} ohms at "open" position; input insulation is entirely teflon and siliconized glass, insuring reliable operation under high humidity conditions.

Drift: less than 2 mv per hour after initial warm up.

Temperature, Humidity, Line-Voltage Effects: all negligible.

Output: panel meter indicates voltage, current and resistance; output jack provided for connecting recorder having resistance up to 1500Ω.

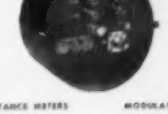
Guard Terminals: three terminals in addition to input and output provide versatility in ground and guard connections.

Input Switch Disconnects Unknown: without upsetting unknown or electrometer input circuit.

Power Supply: 105-125v (210-250v), 50-60 cycles.

Useful Accessories:
Esterline Angus 5-ma or 1-ma Graphic Recorder.

G-R Type 1230-P1 Component Shield at $40 provides a fully shielded chamber for measurement of very high resistance components.



WE SELL DIRECT
Prices are net, FOB Cambridge or West Concord, Mass.

GENERAL RADIO Company

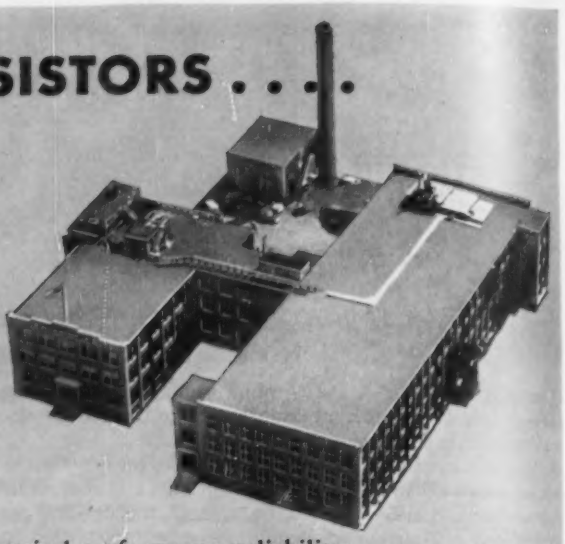
275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

90 West Street **NEW YORK 6** — 8055 13th St., Silver Spring, Md. **WASHINGTON, D. C.**
1150 York Road, Abington, Pa. **PHILADELPHIA**
920 S. Michigan Ave. **CHICAGO 5** — 1000 N. Seward St. **LOS ANGELES 38**

ADMITTANCE METERS
AMPLIFIERS
COAXIAL ELEMENTS
DISTORTION METERS
FREQUENCY MEASURING APPARATUS
FREQUENCY STANDARDS
IMPEDANCE BRIDGES
LIGHT METERS
MEGOHMMETERS
MODULATION METERS
MOTOR CONTROLS
NULL DETECTORS
OSCILLATORS
PARTS & ACCESSORIES
POLARISCOPES
PRECISION CAPACITORS
PULSE GENERATORS
R-L-C DECADES
R-L-C STANDARDS
SIGNAL GENERATORS
SOUND & VIBRATION METERS
STROBOSCOPES
TV & BROADCAST MONITORS
U-H-F MEASURING EQUIPMENT
UNIT INSTRUMENTS
VARIACS
V-T VOLTMETERS
WAVE ANALYZERS
WAVE FILTERS

FIRST PLACE for TRANSISTORS . . . .

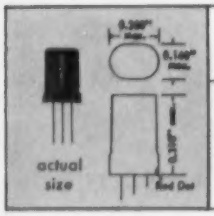
RAYTHEON



Raytheon's three million dollar Semiconductor Division plants devote 180,000 square feet (over 4 acres) of floor space exclusively to semiconductor research, engineering and manufacturing. Raytheon's semiconductor operations employ 1500 people, including over a hundred scientists and engineers.

Raytheon Transistors possess the improved electrical performance, reliability and mass production advantages of Raytheon's *fusion-alloy* process — proved superior by the successful production of *millions* of transistors — more than all other makes combined.

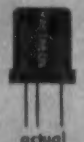
SUBMINIATURE LOW FREQUENCY TRANSISTORS



Type	Collector Volts	Collector Meg. ohms	Collector Cutoff μA	Emitter Current mA	Base Resistance ohms	Base Current Ampl. Factor	Max. Noise Factor db	Alpha Freq. Cutoff mc.
2N130	−6	2.0	6	−1.0	350	22	25	0.6
2N131	−6	2.0	6	−1.0	700	45	22	0.8
2N132	−6	2.0	6	−1.0	1500	90	20	1.2
2N133	−1.5	1.0	6	−0.5	700	45	10	0.8
2N138	−6	2.0	6	−1.0	1800	140	25	1.2

Maximum Junction Temperature 85°C. Temperature Rise (free air) 0.45°C/mW

LOW FREQUENCY TRANSISTORS



Type	Collector Volts	Collector Meg. ohms	Collector Cutoff μA	Emitter Current mA	Base Resistance ohms	Base Current Ampl. Factor	Max. Noise Factor db	Alpha Freq. Cutoff mc.
2N63	−6	2.0	6	−1.0	350	22	25	0.6
2N64	−6	2.0	6	−1.0	700	45	22	0.8
2N65	−6	2.0	6	−1.0	1500	90	20	1.2
2N106	−1.5	1.0	6	−0.5	700	45	12	0.8

Maximum Junction Temperature 85°C. Temperature Rise (free air) 0.40°C/mW

HIGH FREQUENCY TRANSISTORS

Type	Collector Volts	Collector Cutoff μA	Emitter Current mA	Extrinsic Base Resis. ohms	Base Current Ampl. Factor	Alpha Freq. Cutoff mc.	Collector Capacity μμf	Gain (max. available) at 455kc db	Gain (max. available) at 2 mc db	Grounded Emitter Switching Ib = −1ma, Ic = −20 ma. Rise time μsec.	Storage time μsec.	Decay time μsec.
2N111	−6	1	−1.0	50	25	3	12	33	18	–	–	–
2N112	−6	1	−1.0	55	40	5	12	35	20	0.8	0.5	1.0
2N113	−6	1	−1.0	60	65	10	12	36	22	0.1	0.6	0.15
2N114	−6	1	−1.0	75	100	20	12	36	25	0.05	0.7	0.10

Maximum Junction Temperature 85°C. Temperature Rise (free air) 0.40°C/mW

NEW HIGH TEMPERATURE SILICON TRANSISTORS

Type	Reverse Current at −20v Collector μA (max.)	Reverse Current at −20v Emitter μA (max.)	Beta	Base Resistance ohms	Collector Resistance kilohms	Noise Factor db (max.)	Collector Capacity μμf	Alpha Freq. Cutoff KC
CK790	0.2	0.2	14	1200	500	30	30	400
CK791	0.2	0.2	24	1400	500	30	30	600
CK793	0.2	0.2	16	1300	500	15	30	500

Maximum Junction Temperature 150°C. Temperature Rise (free air) 0.50°C/mW

All Types Hermetically Sealed

Write for data sheets

RAYTHEON TRANSISTORS

more in use than all other makes combined

the prime source of

special tubes

RAYTHEON

America's Largest Special Tube Manufacturer

CK5783WA
Subminiature Voltage Reference Tube featuring extraordinary stability.

CK6611
CK6612
Filamentary Subminiature Tubes for low battery drain plus high transconductance.

6AN5WA
Reliable Miniature Tube combining high perveance and long life with low interface resistance.

CK6533
Heater Cathode Subminiature tube featuring extremely low microphonics over the audio range.

Here are a few recent additions to the comprehensive range of tubes originated by Raytheon. They are representative of *over two hundred* active miniature and subminiature types out of the many developed and produced by Raytheon.

RAYTHEON manufacturing co.

SPECIAL TUBE DIVISION

RELIABLE MINIATURE AND SUBMINIATURE TUBES • VOLTAGE REFERENCE TUBES
VOLTAGE REGULATOR TUBES • PENCIL TUBES • NUCLEONIC TUBES

Boston Home Office: 55 Chapel St. Newton, Mass. • Bigelow 4-7500
For application information write or call the Home Office or:
New York: 589 Fifth Ave., PLaza 9-3900
Chicago: 9501 Grand Ave., Franklin Park, TUxedo 9-5400
Los Angeles: 622 S. La Brea Ave., WEbster 8-2851

Want more information? Use post card on last page.

are made by over twenty companies in the U. S.

▶**Sales** — For individual companies, volume of sealing unit sales for 1955 ranged from $50,000 to the 1.2-million announced by the Thermatron Division of Radio Receptor Corp.

The trend in sales has been up, with many companies experiencing a ten-fold increase within the past five years.

▶**Prices**—Power output and application determine the price of sealing units. The range is from about $1,000 to $50,000 a machine. The average machine is rated at 3 kw and sells for about $2,000

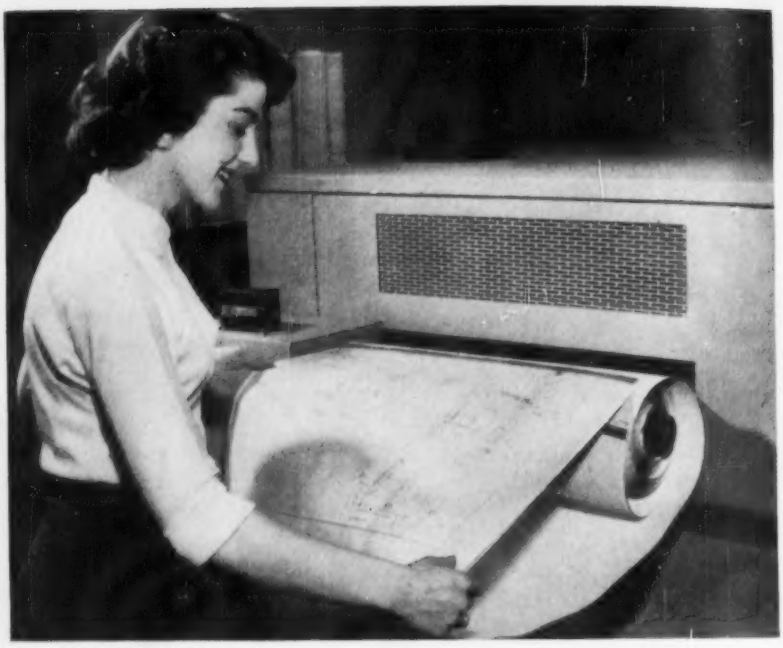
▶**Example**—Kabar Manufacturing of N. Y. produces 1 through 6, 8, 10, 15 and 20-kw units. Price increases in the 3 to 6-kw group average $500/kw, while those in the 8 to 20-kw group average $750/kw. The power required for a given operation depends on the number of linear inches of seal and the thickness of the material.

▶**Problem** — Fulfilling the radiation requirements set by the FCC is a major problem to manufacturers. Although units are engineered for minimum radiation, the user's setup may allow considerable radiation. The only sure way to eliminate the problem is to operate the equipment in a shielded room.

▶**Uses**—Sealers are used in such applications as curing rubber, dehydrating, pre-heating plastics before moulding, making padded safety equipment for autos and sterilizing beer after bottling. Manufacturers feel that units now being produced are not aimed for a replacement market but result from stimulating new manufacturing fields.

▶**Other**—Tappan Stove of Ohio is producing dielectric ranges for the home (see Industry Report, p 12, Dec. 55).

GE and its subsidiary Hotpoint have already announced definite plans to produce high frequency ranges for the home. Raytheon has had commercial units available for some time.



PHOTOGRAPHIC enlarger that uses high voltage is an important step as . . .

Electronics Invades Graphic Arts

Electronic printing and special crt's to aid printing business

INDICATIONS are that the electronics industry which has already become part and parcel of countless diverse businesses from railroading to brewing beer may become an important factor in the printing industry. Printing is the third largest industry in U. S. in number of establishments. Gross sales for 1952 were $8.5 million. Related to printing are blueprinting, office duplication and photo reproduction.

▶**Navy "Blueprinter"**—The Electrofax machine shown was built by RCA for the Navy's aircraft overhaul and repair facility in Alameda, Calif. It produces 15 engineering drawings a minute from microfilm originals. It sells for $85,000.

The printing paper is automatically sensitized by a high-voltage field. A light image is then projected onto it. The latent image is developed by a magnetic brush. This consists of a mass of iron filings held by a magnet. The iron filings carry positively charged pigmented resin powder. The powdered ink clings to the negatively charged areas of the exposure. The image is fixed by heat.

▶**Other Printers** — Other electrostatic printers include the Xerographic process of Haloid and the Electrographic process under development by Burroughs. A recent development by Haloid has been preparing printed circuits by Xerography. Smoke printing, a Standard Register process is essentially electrostatic. However, the pigmented material is in the form of a fine mist.

General Electric and IBM have experimented with electromagnetic dry printing processes.

▶**Future**—Ultimate in electronic printing would be to display data as alphabetic and numeric characters on the face of a cathode-ray tube and produce permanent copy by electronic printing.

The Charactron, developed by Convair, uses special beam-forming plates to provide an electron-image beam that can display characters on the crt screen. Charactrons are used for reading data out of air-defense computers in Sage.

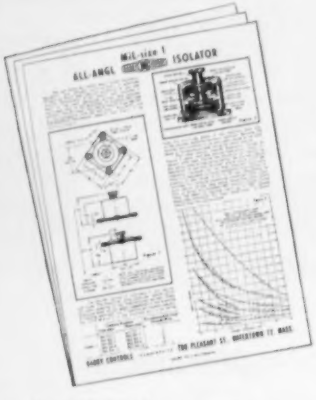
(Continued on page 27

Advertisement

HOW to CHOOSE VIBRATION MOUNTS

For Jet and Missile Applications

Use our free engineering data sheets on ALL-ANGL Barrymount® Isolators. They describe and illustrate the operating principle of the ALL-ANGL Barry Mount, telling how it works to control shock and high-frequency vibration. They give



you load-deflection curves, transmissibility curves, and load-versus-natural-frequency curves that show how these isolators perform under various loads and vibration inputs and for different directions of applied acceleration. They explain how these curves can be used to evaluate isolator performance. And they contain detailed drawings that show all necessary dimensions and clearances.

Because of their proved efficacy in protecting delicate electronic apparatus through every flight attitude, ALL-ANGL Barry Mounts give the designer valuable aid in cramming the most instrumentation into the least space. They make it practicable to mount equipment on any available surface — upright on a deck or shelf, hung from above, attached to a bulkhead, or at any angle necessary to fit a unit into limited space. Regardless of mounting position, ALL-ANGL Barry Mounts give protection against high-frequency vibration through every operational maneuver of the most modern aircraft.

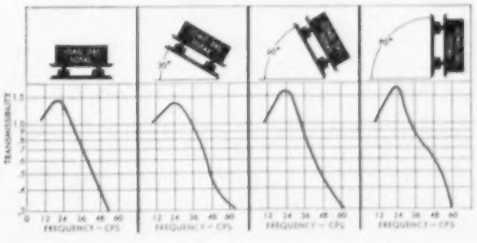
Barry engineering data sheets are free on request. Write for your copies today.

ALL-ANGL BARRY B MOUNT ISOLATORS

give vital in-flight reliability protection

Sure, you can meet the *specification* with a mount that only has to work at a 10-degree tilt. But what happens when the aircraft climbs at steep angles or goes into a 90-degree turn or dive?

That's where you need ALL-ANGL Barrymount® Isolators. You can mount 'em and *fly 'em* at any cock-eyed angle you choose. And they give the same sure protection to vital instruments and controls from take-off through every twist, turn, and dive of the aircraft's most violent maneuvers. These curves show why.



Write now for data sheets AA-0-1 containing detailed performance data. And remember — when your problem is protection thru every flight attitude, your answer is ALL-ANGL Barry Mounts. For recommendations, call your nearest Barry Sales Representative.

BARRY CONTROLS INCORPORATED

BARRY B MOUNT
SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

707 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

Want more information? Use post card on last page.

A project is reported underway by Convair, Haloid, IBM and Eastman-Kodak to combine electronic printing with Charactron readout. One important application would be instantaneous printing of data from high-speed computers

RCA has a so-called typesetter tube. A font of characters is imaged onto a photoemissive cathode. This forms the electron image beam that produces characters on the face of the cathode-ray tube. The company is looking into combining Electrofax with the crt typesetter. An initial application might be high-speed readout—perhaps for the Bizmac computers.

THREE-INCH wide magnetic tape is used as . . .

New Business Computer Appears

Fourth manufacturer builds giant machine. More activity evident throughout industry

PROGENY of Raytheon and Minneapolis-Honeywell, DATAmatic Corp. of Newton Highlands, Mass. last month became the fourth firm to offer a large-scale digital computer for business and industry.

The DATAmatic 1000 sells for $1.5 million. The computer is planned in building blocks. For example, up to 100 magnetic files can be utilized. Running at 100 in. a second, each file can handle up to 60,000 decimal digits a second.

▶ **Wide Tape**—The machine is notable for use of a 3-in. wide tape with 31 parallel recording channels. Bits comprising the words are handled serially. Each numeric word consists of 11 decimal digits and sign. The tape is a plastic sandwich to protect the magnetic recording surface. Tape reels are 2,700 ft long and store more than 37 million decimal digits.

The machine uses a three-address code. Another feature is automatically controlled scanning of up to 10 tapes at once. This gives a scanning rate of 600,000 decimal digits a second.

The input converter handles 900 punched cards a minute. Output is to punched cards—6,000 an hour, or printed records—either 150 120-character lines or 600 to 900 120-character lines a minute.

Other makers of large-scale computers are IBM with the 700 series, Sperry Rand with Univacs and RCA with Bizmac. A Bizmac was recently delivered to Army Ordnance in Detroit. A second machine is reported under development for business use.

▶ **Other Machines**—National Cash Register, which took over Computer Research and its CRC-102 machines some time ago, expects to offer a medium-sized digital computer for business and industry—perhaps this summer. Electronics Corp. of America is showing the Magnefile, a special-purpose machine designed for inventory work. A model is undergoing field trial in a New York department store.

▶ **Special Machines**—In the special-purpose machine field, Sperry Rand's St. Paul operation recently announced an order from Northwest Airlines for a computer to control airline reservations. Teleregister of Stamford, Conn. has been active in this field serving American Airlines, United Air Lines, N. Y. Central Railroad, National Airlines, Braniff, the Santa Fe and the New Haven.

Transistor-Silicon Sources To Increase

One refiner to enter supply market by mid-1956. Others may join in soon after

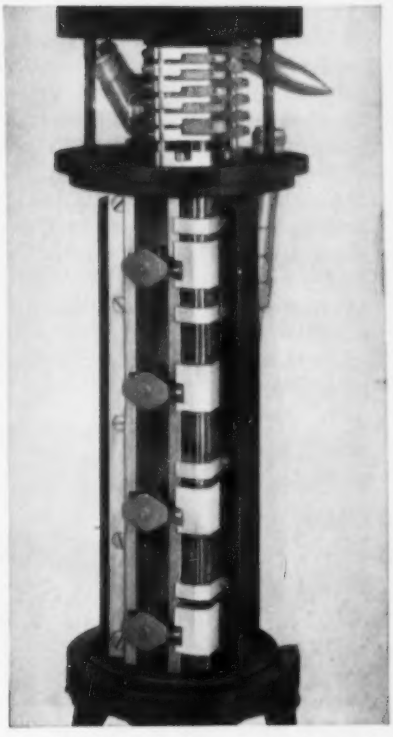
AT LEAST five companies have been investigating silicon processing techniques which will permit them to enter the market as suppliers. One, Sylvania, has successfully developed a zinc-reduction process and expects to be producing 300 pounds of high-purity silicon within three to five months. Sample quantities of 100 grams, refined by this process, are available now.

▶ **Prices**—Since November 1954, high-purity silicon has been selling for $380 a pound. Before that time, the price was $430 a pound. These high prices are partially attributed to the fact that silicon production has been and is today on a semi pilot-plant basis.

▶ **Specifications**—What constitutes transistor-grade silicon has been a continual source of confusion. Percentage values of purity are meaningless, since impurities are present of the order of 1 part in 10

(Continued on page 24)

A research engineer at the General Electric Microwave Laboratory, Palo Alto, California, measures the output-cavity tuning characteristics of G.E.'s new 15-kw high-gain klystron that features single-knob tuning.



Four knurled knobs (top of picture), one for each cavity—plus a fifth, master knob that gang-tunes the klystron—control the tuning adjustment through precision mechanical linkage. In normal band switching, only the master knob is used by the operator.

G-E klystron research originates single-knob tuning . . . for rapid band switching . . . for flat power output!

More efficient use of klystrons for radar—military and commercial—is a direct result of single-knob tuning pioneered by General Electric research. Band switching, whether to counter enemy jamming, to avoid friendly signal interference, or for other purposes, now is fast and sure—entails no loss of power.

One control knob tunes the new G-E klystron over its full 200-mc frequency range . . . and this control can be remotely actuated by cable or other device.

The operator needs no special knowledge or training to switch the General Electric klystron from one band to another—the four cavities are pre-tuned, and their alignment is preserved at all times. Power output of the klystron stays flat and high over the entire frequency range, varying less than 1 db.

General Electric has led in klystron research and development, applying major resources in order to realize the full potential of these long-life, high-gain microwave tubes. G-E single-knob tuning advances klystron design still further. Ask for full information! Consult with G-E tube engineers on any problem which involves klystron choice and application! *Tube Department, General Electric Company, Schenectady 5, New York.*

CHARACTERISTICS OF NEW G-E KLYSTRON:

Peak power output	15 kw
Tuning range	2500 to 2700 mc
Efficiency	40 percent
Gain	53 db
Beam voltage	20.5 kv
Avg power output	150 w
Duty cycle	.1 percent
Magnetic field requirements	600 to 700 gauss

Progress Is Our Most Important Product

GENERAL ELECTRIC

162-183

to 10⁹. At these values, normal methods of chemical analysis to determine purity are totally unsuitable making it necessary to measure the resistivity of single crystals grown from each batch.

To help establish a standard, the Industrial Mobilization Activity has prepared a specification for transistor-grade silicon. It is believed that commercial production of silicon to meet these specifications will raise the quality of silicon to be sold and will aid in the development of various transistor devices.

ENGINE performance of sports car is rapidly checked out as.....

Electronics Aids Ignition Mechanics

Dynamic engine analyzer developed by oil company is marketed by electronics firm

RELATIVELY INEXPERIENCED personnel can now analyze automotive engine troubles in only a few minutes with the help of an electronic engine analyzer. Developed over a period of years by Socony-Mobil Oil Co., for use in its laboratories and for field work, the prototype version of the instrument has been redesigned by Du Mont for volume production.

The commercial version of the instrument sells for $725 and is aimed at the automotive servicing market.

► **What It Does**—When connected to a car engine by two clip-on leads, the instrument shows simultaneous waveform presentations of the behavior of each cylinder of the engine. The condition of the capacitor, spark coil and plugs can be determined from the waveforms.

TV Screen Sizes Start To Shrink

Smaller picture tubes gain as lightweight portables for second set market increase

PUBLIC preference for larger tv screens seems to have reached saturation. Now smaller tubes under 15 inches are making a comeback. A year ago, the set industry was still pushing larger screens, the 24-inch and 27-inch set and wondering how far the large screen trend would go. Now the question seems to be how small a screen can be sold.

► **New Model**—RCA is now in production on a portable set with an 8½-inch screen. It measures 10¼-inches high, 9¼-inches wide and 10¾-inches deep. The new tube incorporates an electrostatic focus gun and its length has been reduced to 10¾ inches by using wide-angle 90-degree deflection. The chassis has 10 tubes plus kinescope, four crystals, one tube rectifier and a double selenium rectifier. Seven of the 10 tubes are double purpose.

General Electric triggered the trend to smaller screens when it introduced its 14-inch portable tv sets last year. Sales exceeded expectations and now the firm has three new 14-inch portables on the market. (ELECTRONICS, p. 20, Feb. 1956).

New RCA portable tv receiver with 8½ inch screen

► **Why**—In addition to the lower retail prices that the smaller sets make possible, their success is generally attributed to the growing replacement and second set markets which are estimated to account for half of all tv set sales.

► **Market**—Rise in sales of smaller-sized picture tubes as a result of the trend to portables does not yet show up in available RETMA statistics. But past sales trends of tubes under 15 inches indicate how far small-tube business has dropped. Even with increased sales of 14-inch sets last year, all tubes under 15-inches accounted for less than 3 percent of total picture tube sales.

Banks Extend Services By Facsimile Link

Two Boston banks use service to tie branches to central bookkeeper

TWO RECENT installations of facsimile equipment in Massachusetts have put into action the interest that banking companies have shown in electronics as a labor-saving device.

In both the Provident Institution for Savings in Boston and the Worcester County Institution for Savings, teller's cages in the main office and branches are tied to a central bookkeeping department by high-speed facsimile units. Copies of bank balance cards and signatures are transmitted to the teller on request in 5 to 6 seconds.

► **Permanent Records** — Advantages claimed for the facsimile method of connecting branches with the main office are the lower maintenance costs and the production of a permanent record.

► **Cost**—The $8,000 system is serviced by Alden Electronic and Impulse Recording Equipment Co. The facsimile is used with a punch-

(Continued on page 26)

10 KC

540 KC

IN THE 10 KC TO 540 KC RANGE...

the New **SP-600-VLF**
communications receiver

The new SP-600-VLF is *more* than just a receiver–it is a precision communications instrument that operates over the entire range from 10 KC to 540 KC with outstanding stability and precise calibration. It offers features and quality found in no other receivers–even those costing twice as much.

As a communications receiver, the SP-600-VLF is ideal for applications in AM radio telephone, CW telegraph, AM-MCW telegraph signals and carrier-shift radio teletype signals, as well as many military communication requirements.

As a laboratory instrument, the SP-600-VLF may be used in making measurements of low-frequency null detector devices, sonar equipment, and any other application where a stable, precisely calibrated very-low-frequency demodulating instrument is required.

The SP-600-VLF offers continuous tuning over the entire range from 10 KC to 540 KC in 6 bands. Exceptionally fine tuning mechanism plus a vernier dial provides continuous expanded scales over each frequency band for accurate logging and resetability. All components have characteristics equivalent to military component specifications as is practical.

Whether you need a really good VLF communications receiver, or a precise VLF laboratory instrument–you'll find there is no equal to the SP-600-VLF at any price.

FEATURES

- **50:1 ratio between tuning control and main dial. 6:1 ratio between main dial and vernier.**
- **Provision for crystal-controlled fixed frequency reception.**
- **Extremely low drift–between .05% and 1.0% depending upon frequency.**
- **Noise limiter circuit reduces pulse type interference.**
- **Send-receive switch eliminates warm-up time between messages.**
- **2-stage RF amplification provided on all bands.**
- **Taps provided for operation on 90 to 270 Volts, 50/60 cycle.**

SEND FOR COMPLETE TECHNICAL SPECIFICATIONS BULLETIN E456

Established 1910

HAMMARLUND

HAMMARLUND MANUFACTURING CO., Inc. 460 WEST 34th STREET, NEW YORK 1, N. Y.
INTERNATIONAL DIVISION: 13 East 40th Street, New York 16, N.Y.

Want more information? Use post card on last page.

Branch teller gets deposit card in 5 seconds via facsimile

tape bookkeeping system that reduces time on a deposit transaction to about 30 seconds.

Television Set Penetration Deepens

TELEVISION receivers in the U. S., both color and monochrome, totalled 36.9 million on Jan. 1, 1956 and may reach 39.8 million by the beginning of next year, according to new NBC estimates. Nearly 71 percent of the 48.6 million homes in the country are now tv equipped and penetration is expected to reach nearly 74 percent by the first of 1957.

► **Markets**—At the beginning of the year, there were 1.5 million secondary sets in homes. The number may increase to 2 million by the first of 1957. The figures indicate that 4.2 percent of all tv homes now have more than one set. It may soon go over 5 percent.

Sets in hotels, motels and institutions of all kinds are estimated at 1 million and are expected to total 1.3 million by 1957.

► **Replacement** — Growing proportion of new set sales are replacements for sets being scrapped. At the end of 1953 accumulated scrappage was about 800,000.

In 1955 about 40 percent of the 7.4 million sets sold replaced sets scrapped. Total set scrappage now is estimated at over 6 million.

FUTURE MEETINGS

APRIL 2-4: Harvard University, Air Force Cambridge Research Center, IRE Symposium on Microwave Properties and Applications of Ferrites, Harvard University, Cambridge, Mass.

APRIL 5-6: IRE, AIEE, ISA, Magnetic Amplifier Conference, Hotel Syracuse, Syracuse, N. Y.

APRIL 11-13: 1956 IRE 7th Region Technical Conference, Hotel Utah, Salt Lake City.

APRIL 13-14: Tenth Annual Spring Television Conference, IRE, Engineering Society Building, Cincinnati, Ohio.

APRIL 16-18-19: NARTB Tenth Annual Broadcast Engineering Conference, Conrad Hilton Hotel, Chicago, Ill.

APRIL 23-24: New England Radio Engineering Meeting, IRE, Sheraton Plaza, Boston.

APRIL 23-25: International Conference on Electron Physics, NBS, College Park, Md.

APRIL 25-27: Symposium On Nonlinear Circuit Analysis, II, Polytechnic Institute of Brooklyn, New York, N. Y.

APRIL 26-27: Conference On Recording and Controlling Instruments, AIEE, ASME, ISA, Bradford Hotel, Boston.

APRIL 29-MAY 3: Fourth Annual Semiconductor Symposium, Electrochemical Society, Mark Hopkins Hotel, San Francisco.

APRIL 30-MAY 3: URSI Spring Meeting, NBS, Wash., D. C.

APRIL 30-MAY 4: SMPTE 79th semiannual convention and exhibit, Hotel Statler, New York, N. Y.

MAY 1-3: The 1956 Electronic Components Symposium, U. S. Department of Interior Auditorium, Washington, D. C.

MAY 14-16: National Aeronautical & Navigational Conference, PGANE, Biltmore Hotel, Dayton, Ohio.

MAY 14-17: The Design Engineering Show and Conference, Philadelphia, Pa.

MAY 15-16: Industrial Nuclear Technology Conference, NUCLEONICS, Armour Research, Museum of Science andIndustry, Chicago, Ill.

MAY 17-19: Thirtieth Engineering Industries Exposition and Annual Convention, New York State Society of Professional Engineers, Statler Hotel, New York, N. Y.

MAY 21-24: Electronics Parts Distributors Show, Conrad Hilton Hotel, Chicago, Ill.

MAY 21-22: RETMA Symposium on Reliable Applications of Electron Tubes, Irvine Auditorium, University of Penna., Philadelphia, Pa.

MAY 23-26: Annual meeting, National Society of Professional Engineers, Ambassador Hotel, Atlantic City, N. J.

Industry Shorts

► **Electronics** industry will grow by some 66 percent in the next eight years to reach a volume of $18 billion, according to an announcement by RCA.

► **Motorola** has entered auto-radio after-market with eight-tube plus one-transistor hybrid set that will fit a number of 1956 models.

► **Million mark** in color tv sales may not be reached until 1958 and it may be 1959 or 1960 before color equalizes with black and white in total units sold, according to Dr. W. R. G. Baker of GE.

► **Royal** Air Force has created a new aircrew category of air electronics officers, primarily for Britain's V-bomber force.

► **Navy** awarded a $22.7 million contract to Westinghouse for the Aero 13 fire-control system to be installed in the Douglas F4D Skyray.

► **Plan** whereby one share of Burroughs common stock will be issued for each two shares of outstanding Electrodata stock is in the works.

► **Estimated** 1,100 tons of metal powder was used for magnetic cores in 1955.

WIDE RANGE WIDE SWEEP- Sweeping OSCILLATOR

The KAY CALIBRATED Mega-Sweep

- ***Continuously Tunable Thru Video VHF and UHF Frequencies, 50KC-950MC Range***
- ***Sweep Widths to 40 MC***
- ***Single Dial Tuning***

Used with a standard cathode ray oscilloscope, the Kay Calibrated *Mega-Sweep* will display the response characteristic of wide band circuits over the frequency range of approximately 50 kc to 950 mc. It features a calibrated dial indication of the approximate output frequency. The center frequency of the sweeping output voltage may thus be set to an accuracy of about 10%. The calibrated *Mega-Sweep* is the ideal instrument for use in alignment of amplifiers and filters . . . also as an FM source of wide range for instructional and lab purposes.

SPECIFICATIONS

Freq. Range: 50 kc to 1000 mc.

Freq. Sweep: Sawtooth, adjustable to 40 mc. Repetition rate, 50 to 100 c/s.

RF Output: *High*, approx. 100 mv max. into open circuit. *Low*, 5 mv into open circuit.

RF Output Control: Microwave attenuator continuously variable to 26 db.

Output Waveform: Less than 5% harmonic distortion at max. output.

Meter: Provides crystal detector current for peak output.

Regulated Power Supply: 105-125 v., 50 to 60 cps. Power Input, 100 watts.

Send for Catalog 110-A

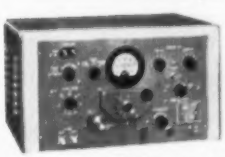
$495 f.o.b. factory

Dept. E-4 **KAY ELECTRIC COMPANY**
14 MAPLE AVENUE PINE BROOK, N. J.
CAldwell 6-4000

KAY
SWEEPING OSCILLATORS for every application

KAY
Mega-Sweep

Widest range of the Kay line of sweeping oscillators. Provides continuous frequency coverage up through UHF-TV bands – 50 kc to 1000 mc. Widely used in radar system development and in alignment and testing of TV and FM systems and components, as well as wide band IF and RF amplifiers and filters. Freq. range, 10 mc to 950 mc. *Write for Catalog 100-A.* Price, **$465** f.o.b. factory.



KAY
111-A CALIBRATED
Mega-Sweep

Higher output model calibrated *Mega-Sweep*, with zero level baseline. Higher output facilitates frequency response testing of UHF converters or tuners. Wider sweep width permits multi-channel response viewing. Zero level baseline is convenient means of measuring gain of test circuit.

SPECIFICATIONS

Frequency Range	Output Impedance	Output Voltage (into Load)
1. 10 mc—950 mc	70 ohms unbalanced	0.15 Volts
2. 450 mc—900 mc	300 ohms balanced	0.3 Volts

Sweep Width: Continuously variable to approx. 40 mc max.

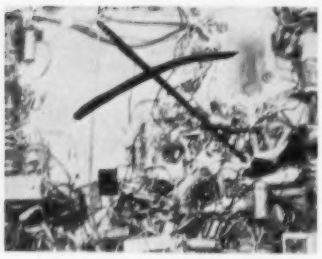
Write for Catalog 111-A Price, **$575** f.o.b. factory

KAY 112-A CALIBRATED *Mega-Sweep*
Same as 111-A, except total frequency range is 800 mc to 1200 mc. *Catalog 112-A.* Price, **$575** f.o.b. factory.

Want more information? Use post card on last page.

ELECTRONIC DESIGN AND PRODUCTION SIMPLIFIED

Plug-in Unit Construction Using Alden Terminal Card System Speeds Output, Eliminates Prototypes, Simplifies Trouble-Shooting and Servicing



NOT THIS — Typical "rat's nest" wiring results from point-to-point construction techniques traditional to the electronics industry.

BUT THIS—Neat, compact vertical "planes of circuitry" result from construction based on Alden Terminal Card Mounting System.

Once the electronic circuitry has been worked out, the construction of a piece of equipment or a system becomes a production engineering problem that is primarily mechanical in nature.

Alden's recognition of this fact has made possible a mass-production system of assembly to the electronics industry. Alden Products Company's time-proven Terminal Card System—based on modular, plug-in unitized construction of functional groupings of circuitry—brings new economies to production runs ranging from 100 to 100,000 pieces.

ADVANTAGES OF THE ALDEN TERMINAL CARD SYSTEM

First, you can lift experimental circuits right from the bread board onto the Alden Terminal Mounting Cards, utilizing the components layout you plan on Alden Full-Scale Planning Sheets. Thus, your production is organized immediately on a function-by-function basis on terminal cards mounted in compact vertical planes.

Second, circuitry organized on Alden Terminal Cards snaps into open-sided Alden Basic Chassis which provide a protective housing and convert each function into a compact plug-in unit.

Third, the finished equipment is easy to "trouble-shoot". You can include Alden "tell-tales" on the front panel of each chassis to indicate any defect instantly. Unskilled personnel spot trouble and replace the plug-in unit within 30 seconds.

Fourth, the Alden Back Connectors mounted on the chassis provide a single, readily accessible point of check for all "in" and "out" leads. These are easily numbered and color-coded so that the layman can make accurate first-level tests.

ELEMENTS OF THE ALDEN TERMINAL CARD SYSTEM

In the Alden System, you get all the elements you need to functionalize your production. Your assemblies are made up on a block diagram basis, as opposed to the normal circuit diagram point-to-point wiring method.

Terminal Cards: These cards are precut to size, in lengths up to 3 feet. They are pre-punched with 0.101" holes on $\frac{1}{4}$" centers for maximum flexibility in chassis layout.

Mounting Sockets: Available for 7, 8, 9 pin connections, miniature and standard octal, tube sockets are furnished for stud mounting or with right-angle brackets for mounting directly to the terminal card.

Miniature Ratchet Terminals: Stake into terminal card and provide positive grip for feed-through or single-end connections for all pigtail-lead components. Soldering serves only to establish the electrical connection. Lead dress is simplified—excess pigtails are snipped off at the terminal.

Jumper Strips: Stake under terminals for either jumper or common wiring. These strips and other wiring can be readily replaced with printed or etched wiring.

WHEN YOU USE THE ALDEN SYSTEM, you enable your production organization to build "custom" products on a true mass-production basis. Production planning is simplified, for at the design stage it becomes natural to break down equipment into simple sub-assemblies of extreme accessibility and ease of manufacture. You can use the Alden Full Scale Planning Sheets and have a custom design tailored to your needs but laid out to use standard components that are simple to procure and go together by the simplest assembly methods.

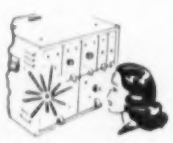
Procurement is made easy because all information comes to your purchasing department from the laboratory beautifully organized on the Planning Sheets. The standard items that are involved help eliminate the headaches of expediting, yet you have custom tailored features which do not delay procurements.

Sub-contracting becomes simpler because you can farm out your work, specifying Alden techniques or supplying Alden parts, and be sure of getting sub-units of satisfactory quality.

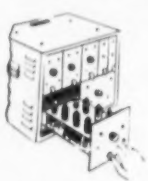
WRITE TODAY on your company letterhead for information on this improved system of designing, manufacturing and servicing.

Electronic Construction and Servicing Are 4 Ways Better

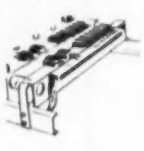
Circuitry subdivided, function by function into attractive plug-in units.



Tiny tell-tales spot trouble instantly, eliminate need for trained technicians on spot.



Layman can plug in replacement spare in 30 seconds.

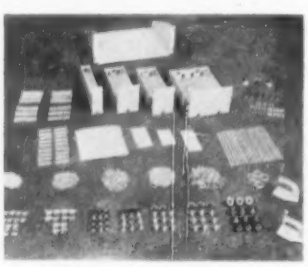


All leads are at a single accessible point, numbered and color-coded so layman can make first-level tests.

ALDEN PRODUCTS COMPANY

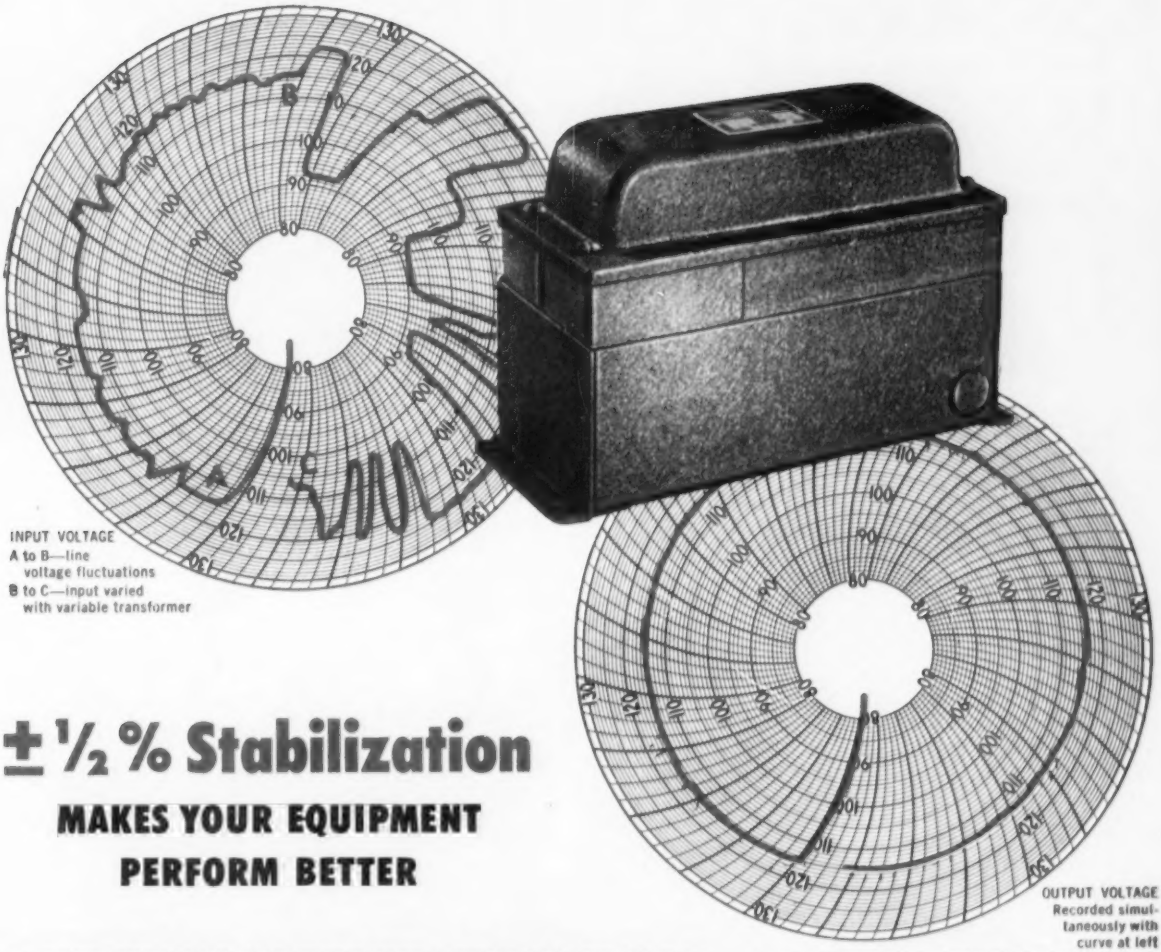
Manufacturing Product Engineers

Brockton, Mass.



WANT TO TRY THE ALDEN SYSTEM?

Send for this complete basic assortment of Alden Circuit Packaging Components. Includes all the elements you'll need to assemble a variety of complete chassis based on the Alden Terminal Card System. Price—$249.50. Ask for Kit #37.



INPUT VOLTAGE
A to B—line voltage fluctuations
B to C—input varied with variable transformer

OUTPUT VOLTAGE
Recorded simultaneously with curve at left

± ½ % Stabilization

MAKES YOUR EQUIPMENT PERFORM BETTER

RAYTHEON VOLTAGE STABILIZERS

These curves demonstrate one simple fact—that if the satisfactory operation of your equipment depends on a well regulated power supply, Raytheon voltage stabilizers are your assurance of top performance under virtually all conditions.

How these curves were made

These curves were traced simultaneously by identical recording voltmeters. The left hand chart indicates input voltage, and the other, output of a standard Model VR-6110 Raytheon voltage stabilizer. Region AB results from actual line variations caused by motor-driven machines. The wider fluctuations, BC, are produced by a variable transformer in the stabilizer input.

26 Models

Raytheon voltage stabilizers are available in a wide variety of input and output voltages from 15 to 2000 watts and, where needed, harmonic filtered models for 250, 500 and 1000 watts.

CHECK THESE IMPORTANT FEATURES

- Guaranteed stabilization to ± ½ %
- Stabilized voltage increases tube life as much as 50%
- Close regulation with temperature and frequency changes
- Response time within 3 cycles
- Compact, rugged, dependable, low-cost

For full information see your electronic supply house or write Dept. 6120—please request bulletin 4-260.

RAYTHEON MANUFACTURING COMPANY

Equipment Marketing Department, Waltham 54, Mass.

RAYTHEON

A-4014

Excellence in Electronics

CAPACITORS
10 seconds or 10,000 hours, whatever the life span required, G-E pulse-forming network capacitors are engineered for the specific job. The life-test data accumulated over more than twelve years helps G-E engineers meet your special conditions exactly.

12 years of test data back your selection of General Electric pulse-forming networks

Capacitor service life requirements from 10 to 10,000 hours filled for hundreds of radar and guided missile applications by accumulated data

Whatever service life your application calls for and whatever the conditions of operation, General Electric can deliver a capacitor pulse-forming network that will give the finest performance for your radar and missile needs.

The reason is the wealth of data accumulated by G-E engineers through twelve years of continuous life tests carried out on capacitor pulse-forming networks of practically every type, operating under widely varying conditions of temperature, voltage, and other service factors. From this data and experience, General Electric has established life limitations that enable networks to be produced that will match almost any specification—whether it calls for a service life of 10 hours or 10,000 hours. In addition, to the exacting needs regarding pulse width, rise time, number of pulses per second, and ripple, special requirements also can be met. These include multiple width networks and size reductions based on forced air circulation.

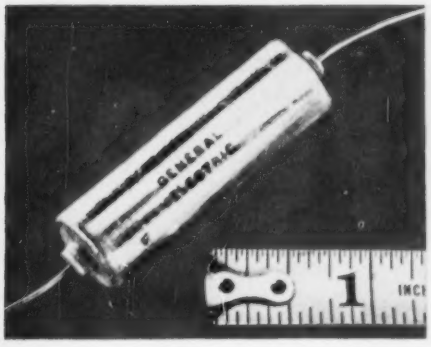
The secret of G-E network performance lies in quality manufacture. Capacitor sections are constructed of low-loss kraft paper and high purity aluminum foil. Inductance coils are wound on threaded forms for stability of inductance throughout the life of the unit. Highest quality mineral oil is used for impregnation. Rugged, hermetically sealed cases help protect all components.

G-E pulse-forming networks have already proved their dependability in thousands of military installations on aircraft, ships, and on the ground, as well as in highly specialized missile applications. The engineering facilities of the Capacitor Department, Hudson Falls, N. Y., are at your disposal. Your local G-E Apparatus Sales Office will see that you receive application assistance with your network problems. Or write for bulletin GEA-4996 to the General Electric Company, Section 442-32, Schenectady 5, N. Y.

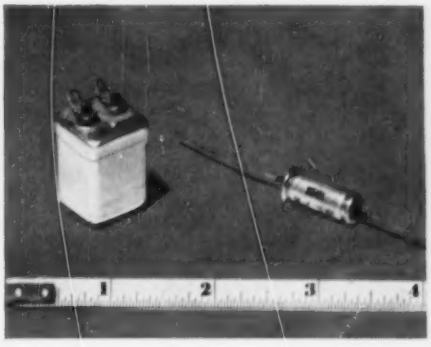
Progress Is Our Most Important Product

GENERAL ELECTRIC

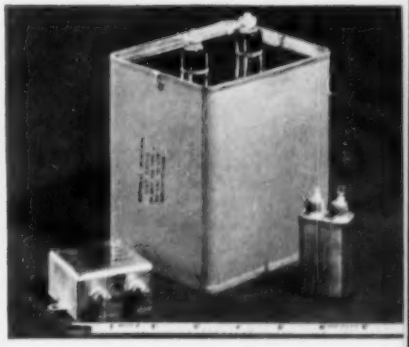
A FULL LINE OF CAPACITORS FOR THE ELECTRONICS INDUSTRY



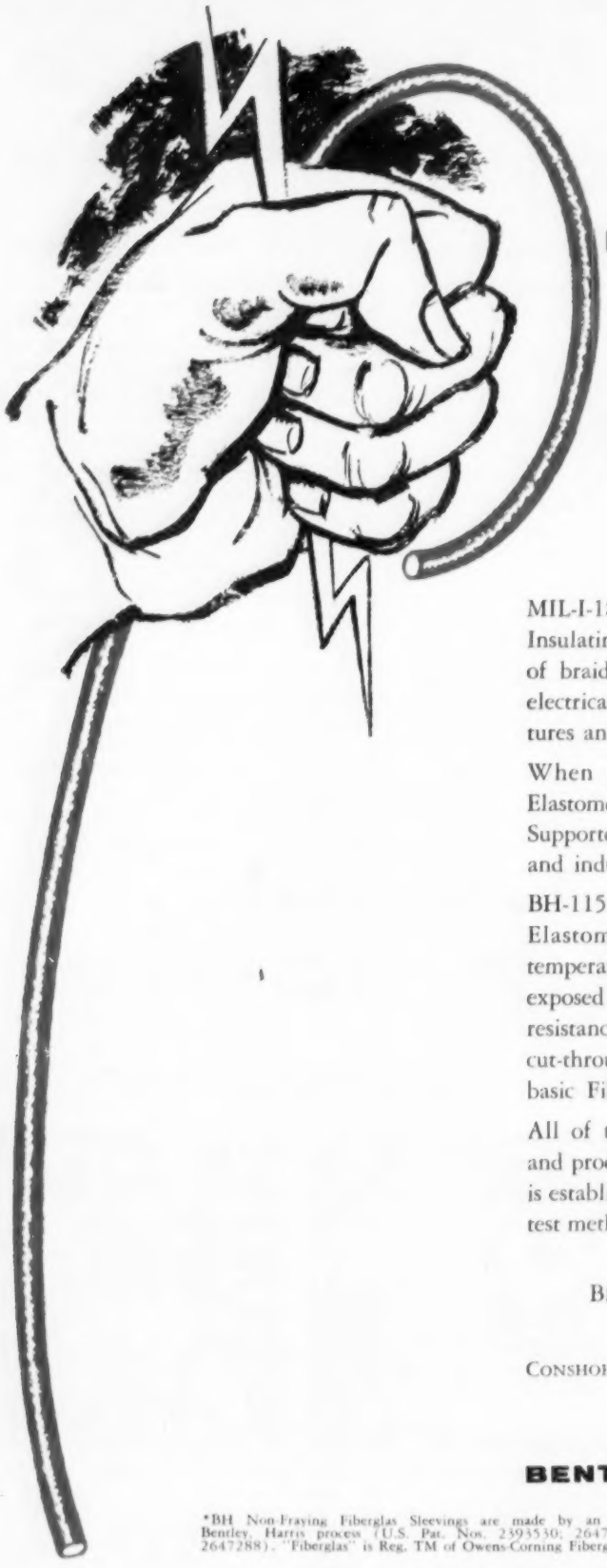
METAL-CLAD TUBULAR CAPACITORS for all d-c uses where utmost reliability is required. Ratings: .001 to 1.0 uf, 100-600 v. d-c. Tol: ±5%, ±10%, or ±20%. Temp. range: −55 C to +125 C with solid impregnant: −55 C to +85 C with mineral oil. Write for GEC-987.



125 C TANTALYTIC® CAPACITORS—for high speed aircraft and missile systems where quality, long life, and small size are main requirements. In plain or etched foil, and rectangular or tubular designs. Ratings: .25 to 180 uf, 10 to 100 volts. Tolerance: +20% (plain foil), −15 to +75% (etched). Temp. range: −55 C to +125 C. Write for GEA-6258. ®Reg. trade-mark of General Electric Co.



MIL-C-25A CAPACITORS—for filter, by-pass, and blocking in military equipment. Built to MIL-C-25A specifications. Ratings: .05 to 15 uf at 100 to 12,500 v. d-c in case styles CP50, CP60, CP70 series. Temp. range: −55 C to +85 C, and −55 C to +125 C. Write for GEC-810.



For all the stringent requirements of MIL-I-18057

BH "1151"

MIL-I-18057 is a functional type test — for Class H Insulating Sleeving. It sets the standard for performance of braided Fiberglas Silicone Elastomeric sleeving in electrical insulating systems subjected to high temperatures and mechanical stress.

When you specify BH-1151 Fiberglas Silicone Elastomeric Sleeving, it meets these high standards. Supported by long record of service in both military and industrial applications.

BH-1151 combines the superior qualities of Silicone Elastomer — extreme low temperature and high temperature flexibility, resistance to degradation when exposed to high temperature, chemical inertness, and resistance to crazing — with the support, resistance to cut-through and dimensional stability offered by the basic Fiberglas braid.

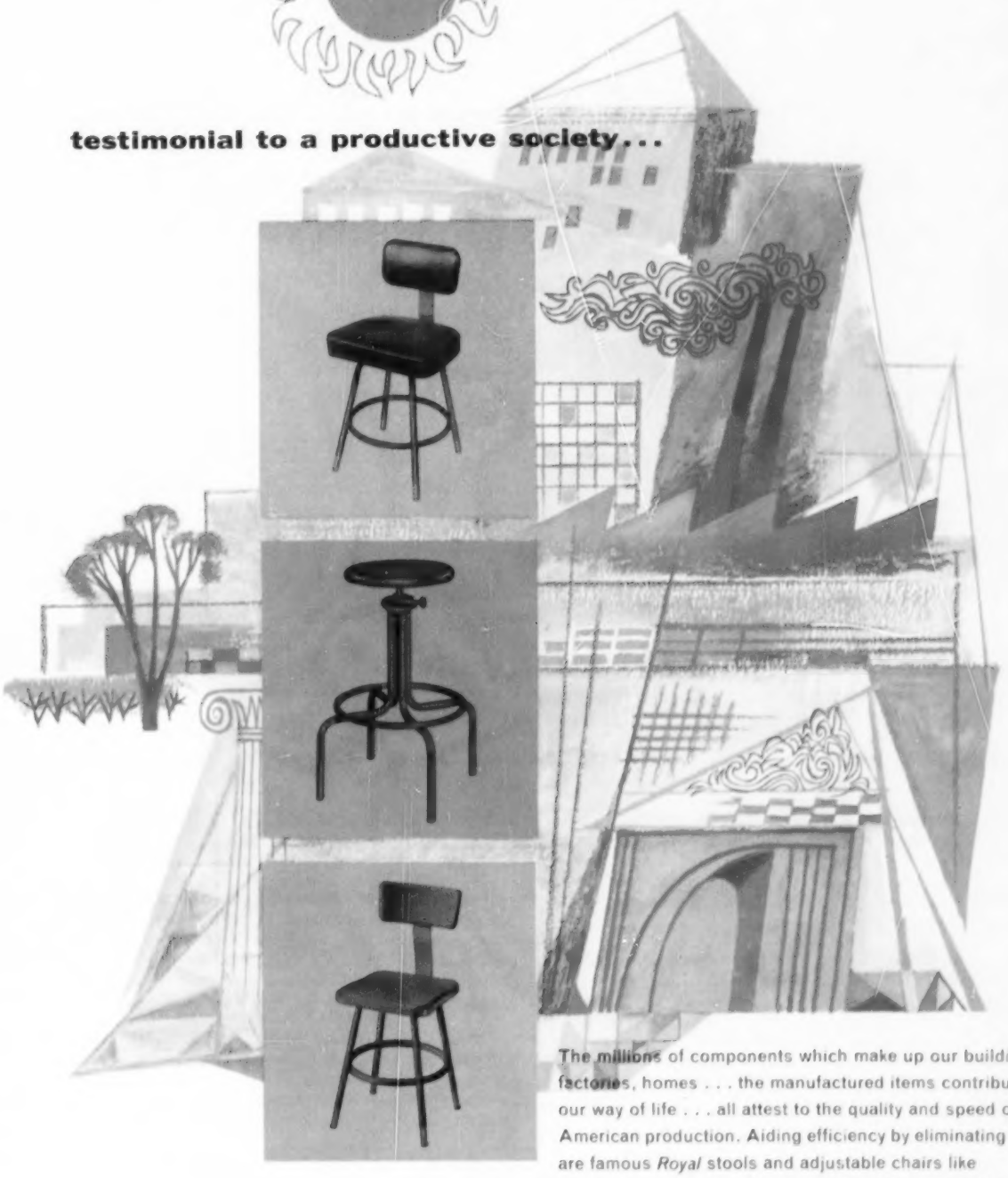
All of these properties are required by MIL-I-18057 and proof of BH-1151's ability to meet these standards is established by data obtained in each of the prescribed test methods. These data sheets are available on request.

BENTLEY, HARRIS MANUFACTURING CO.
1304 Barclay Street
CONSHOHOCKEN, PA. TELEPHONE: TAYLOR 8-0634

BENTLEY, HARRIS *Fiberglas** **SLEEVINGS**

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U.S. Pat. Nos. 2395330; 2647296 and 2647288). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

testimonial to a productive society...



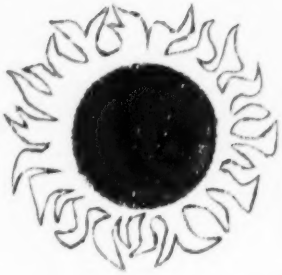
The millions of components which make up our buildings, factories, homes . . . the manufactured items contributing to our way of life . . . all attest to the quality and speed of American production. Aiding efficiency by eliminating fatigue, are famous *Royal* stools and adjustable chairs like these shown. It will pay you to personally inspect the many models available.

now turn the page for additional examples...

Royal

METAL FURNITURE SINCE '97

ROYAL METAL MANUFACTURING COMPANY
175 N. Michigan Avenue • Chicago 1, Illinois
Offices and plants from coast to coast



Shown on the other side of this page, are the 535-S Adjustable Chair, 621-T Stool and the 515-S Adjustable Chair.

ROYAL'S EXCLUSIVE MICRO-HITE SEAT ADJUSTMENT. NO TOOLS . . . WORKS INSTANTLY.

Anyone can operate it effortlessly. Saves extra time when production shifts change. You don't even have to turn unit upside down to make adjustment. Simply raise seat to full height, tighten handwheel, sit down, then release handwheel 'til seat lowers to comfortable working height. Seat stays exactly at that position—no slipping—absolutely safe and dependable.

To meet your every industrial seating problem... *Royal* Factory Seating!

(a) **515-S . . . ADJUSTABLE HEIGHT CHAIR**—Standard equipment in hundreds of leading industrial plants. Back rest adjusts up, down, forward and back. 15-inch wide scroll shaped steel seat fitted with tempered Masonite panel. Construction is all-welded tubular steel. Gray enamel finish. Telescopic legs lock at 1-inch intervals, 17″ to 25″.

(b) **513 . . . ADJUSTABLE CHAIR**—Engineered to encourage proper seating habits—help eliminate backache and fatigue. All-welded tubular steel frame, large shaped back adjusts up, down, forward and back. Steel seat has Masonite panel. Patented leg extensions adjust at 1-inch intervals from 17″ to 25″.

(c) **625-T . . . SWIVEL CHAIR**—One of the finest factory chairs ever engineered. Back rest fully adjustable up, down, forward and back. Scroll-shaped Masonite panel in seat. Rubber-cushioned floor glides. All-welded construction. Equipped with famous *Royal* MICRO-HITE seat height adjustment, from 27″ to 33″. Also 625-M, 22″ to 28″.

(d) **668 . . . SWIVEL CHAIR**—Exceptionally comfortable with extra-thick foam rubber 17″ x 16″ cushion mounted on a heavy-gauge steel seat pan. Form-shaped tilting back rest is well-padded, fully adjustable 4 ways. Has MICRO-HITE seat height mechanism, channel footrest. Model 668-M adjusts 21″ to 27″. Model 668-T, 26″ to 32″.

(e) **511 . . . ADJUSTABLE STOOL**—All-welded tubular steel construction. 14-inch diameter seat has Masonite panel. Patented leg extensions lock securely at 1-inch intervals. Available in two models: 511-S adjustable from 17″ to 25″, and 511-T adjustable from 24″ to 32″. Popular in both office and factory.

Royal Metal Manufacturing Co., Dept. 294
175 N. Michigan Ave., Chicago 1, Ill.

____Please send information on complete line.

____Please have representative call.

Name_____

Address_____

City_____ Zone____ State_____

Royal®
METAL FURNITURE SINCE '97

ROYAL METAL MANUFACTURING COMPANY
175 N. Michigan Ave., Chicago 1, Ill.

Factories: Los Angeles • Michigan City, Ind.
Plainfield, Conn. • Warren, Pa. • Galt, Ontario

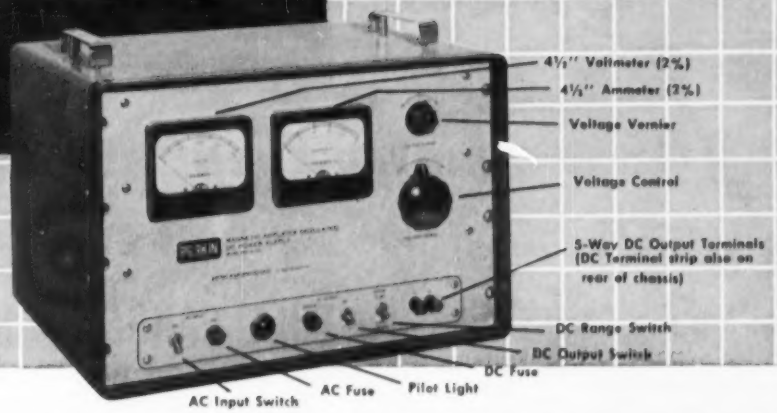
Showrooms: Chicago • Los Angeles
San Francisco • New York City

Authorized Dealers Everywhere.

2 TO 36 VOLTS @ 15 AMPS DC POWER SUPPLY

The NEW PERKIN MODEL MR532-15A *with* ±½% REGULATION

IMMEDIATE DELIVERY !



Now...for Your Laboratory...the most versatile TUBELESS, Regulated and Filtered Power Supply

OTHER STANDARD MODELS AVAILABLE:

VOLTS	AMPS	REG.	MODEL
0-32	25	±1%	M60V
24-32	10	±½%	28-10WX
24-32	30	±½%	28-30WX
5-40	30	±1%	MR 1040A
24-32	100	±½%	100 XA

Ripple on all above models: 1% rms 6, 12 and 115 V models also available. Write for complete specifications on all models listed above.

- **REMOTE SENSING • VERNIER VOLTAGE CONTROL**
- **NO TUBES, MOVING PARTS OR VIBRATING CONTACTS**

Specifications . . . .

REGULATION: 5-32V Range: ± ⅓% for combined line changes of 105-125VAC and load of 0-15A. DC.
2-5V Range: ± 2% for combined line changes of 105-125VAC and load changes of 0-15A. DC.
32-36V Range: ± 2% for combined line changes of 110-125VAC and load changes of 0-15A. DC.

RIPPLE: 1% rms max. @ 36 volts and full load. Increases to 2% @ 2 volts and full load

AC INPUT: 105 to 125 volts, 1 phase, 60 cps. (8 amps, Input)

RESPONSE TIME: 0.1 to 0.2 seconds maximum.

DIMENSIONS: 19½" wide x 15½" deep x 13¼" high with cabinet. (19" wide x 14¾" deep x 12¼" high rack panel construction)

FINISH: Gray Hammertone **WEIGHT:** Approx. 135 lbs.

Representatives in principal cities throughout the country.
Wire collect for complete price information.

PERKIN D C power supplies

PERKIN ENGINEERING CORP.
345 KANSAS ST. • EL SEGUNDO, CALIF. • ORegon 8-7215 or EAstgate 2-1375

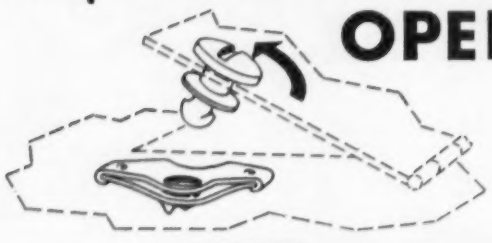
Want more information? Use post card on last page.

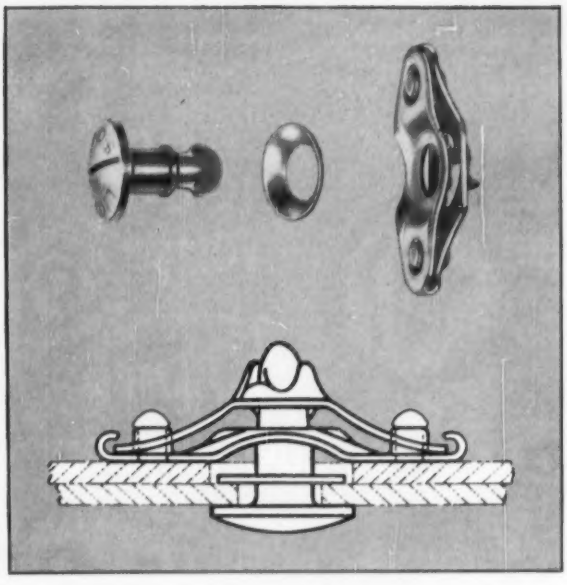
One-quarter turn . . .

CLOSED

One-quarter turn . . .

OPEN





LION *QUARTER-TURN* FASTENERS

QUICK TO INSTALL

Lion Fasteners can be installed rapidly. Studs simply slip through drilled hole and are retained by a grommet. Springs are riveted or spot-welded in place.

RUGGED

Lion Fasteners stand up under the most rugged conditions of shear, tension, and vibration . . . meet or exceed the exacting requirements of Army-Navy-Air Force Specifications MIL-F-5591A (ASG) and have Civil Aeronautics Administration approval for civilian aircraft use.

LIGHTWEIGHT

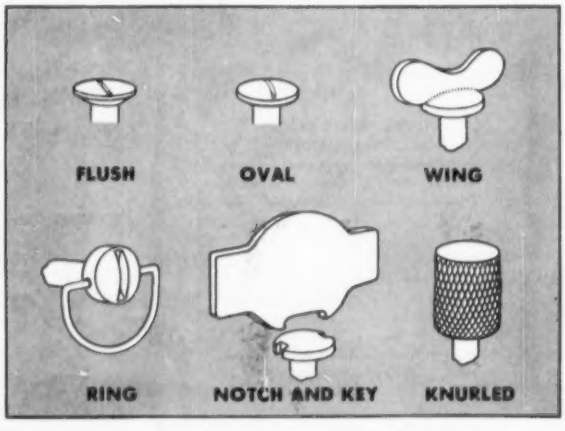
Made of cadmium-plated steel to provide a high strength-low weight ratio, No. 5 Fasteners weigh only 12 to 14 lbs. per 1000 . . . No. 2 Fasteners 3¾ lbs. per 1000 . . . No. H Fasteners approximately 35 lbs. per 1000.

VIBRATION-PROOF

This group of fasteners is particularly suited to metal fastening conditions where vibration is an important factor. Lion Fasteners can't shake loose . . . can't open by themselves.

FULL RANGE OF HEADS...

The Lion No. 5 Fastener is available with flush, oval, ring, wing, knurled, or notched head and key; No. 2 Fastener is available with flush, oval, or wing type head; the No. H Fastener comes with an oval head.



LION *Aviation* **FASTENERS**

one of the **SOUTHCO** FASTENERS

For complete information on Lion Quarter-Turn Fasteners, as well as on the complete Southco line, write today to Southco Division, South Chester Corporation, 233 Industrial Highway, Lester, Pa.

© 1956

Raytheon — World's Largest Manufacturer of Magnetrons and Klystrons

1 MINIATURE — Actual size shown. Diameter, 1¼". Overall length, 2".
Ideal for pulsed beacon applications.

2 EXCELLENT VIBRATION PERFORMANCE
Reliable characteristics up to 10 g.'s from 20 to 1000 c.p.s.

3 MECHANICALLY TUNABLE
Tunes mechanically over X-band region, 9300-9500 Mc min.

4 RUGGED
Withstands 1,000 g. shock along cathode axis. 500 g. in two other perpendicular planes.

5 PULSE POWER
50 watts peak

6 LIGHTWEIGHT — 6 ounces

7 LOW THERMAL FACTOR
Exceptional frequency stability, .05Mc./°C

Magnetron's Actual Size

Challenging Characteristics
FOR YOUR NEW EQUIPMENT DESIGNS

For specifications on the extraordinary QK 362 write today. Ask for copies of latest bulletins listing most of our unclassified Magnetrons and Klystrons and special tubes. Call on us for help in your microwave tube problems. There is no cost or obligation, of course. Similar tubes at other frequencies and power levels are available.

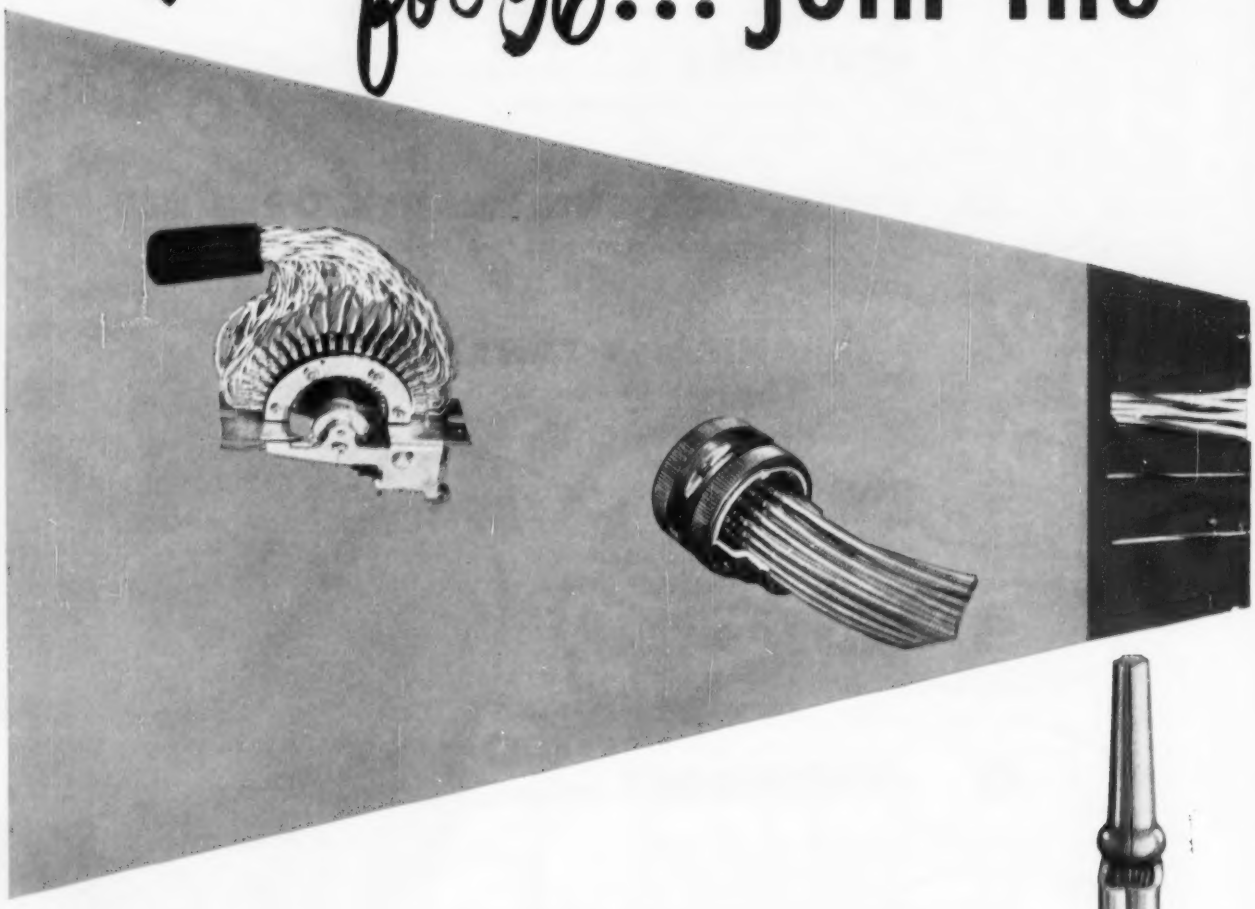
Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

Microwave and Power Tube Operations, Section PT-46
Waltham 54, Massachusetts

Raytheon makes: Magnetrons and Klystrons, Backward Wave Oscillators, Traveling Wave Tubes, Storage Tubes, Power Tubes, Receiving Tubes, Picture Tubes, Transistors.

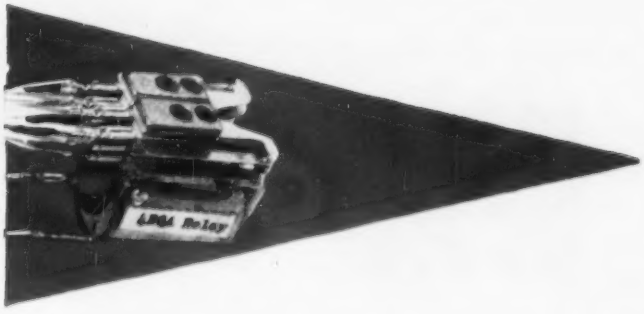
project for '56... join the



AMP

Aircraft-Marine Products, Inc.

®AMP taper parade



Are you in step with the more progressive manufacturers of BUSINESS MACHINES—AIRCRAFT—GUIDED MISSILES—ELECTRONIC EQUIPMENT—who have approved and are profiting by the use of A-MP TAPER TECHNIQUE?

There is still room on the A-MP TAPER TECHNIQUE Band Wagon for you to join the leaders. You, too, can increase speed of assembly, improve reliability, and save money by using A-MP TAPER PINS, TAPER TAB RECEPTACLES, TAPER BLOKS and TAPER TIPS.

And you'll be "cheered on" by the many alert manufacturers of electrical and electronic components who have modified their standard products to help you enjoy the advantages of A-MP TAPER TECHNIQUE.

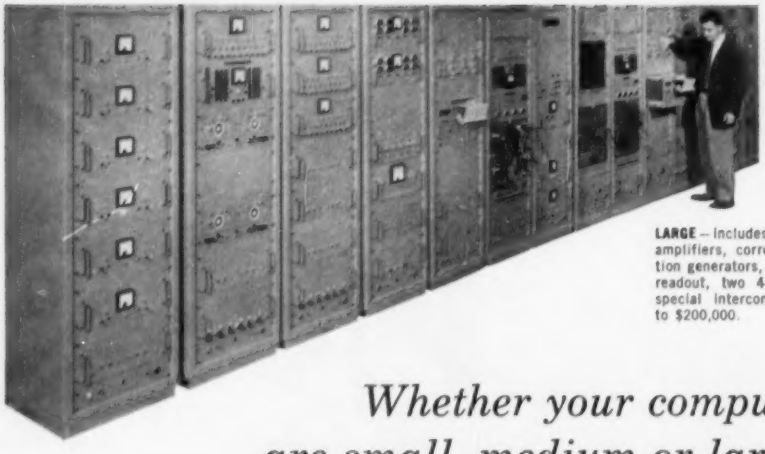
Make it a *MUST* to specify A-MP TAPER TECHNIQUE in your PROJECTS for 1956.

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

1 A-MP of Canada, Ltd. Toronto Canada • 2. A-MP—Holland N.V.'s-Hertogenbosch, Holland
• 3. Aircraft-Marine Products (G.B.) Ltd., London, England • 4. Societe A-MP de France, Courbevoie, Seine, France

*Trademark

Want more information? Use post card on last page.



LARGE – includes two control units with 200 pots, 80 amplifiers, corresponding number of multipliers, function generators, etc., plus digital voltmeter with printed readout, two 4-channel recorders, timing matrix and special interconnecting panel. Price range, $100,000 to $200,000.

Whether your computer needs are small, medium or large –

You Can't Beat An EASE* For ★ FLEXIBILITY ★ CONVENIENCE ★ ACCURACY Per Dollar!

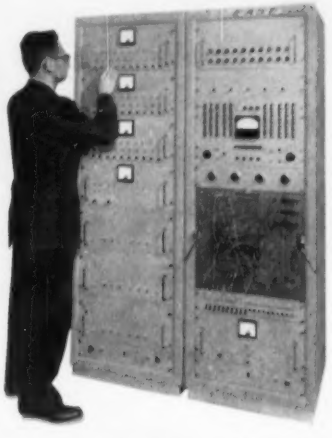
HERE'S WHY:

1. FLEXIBILITY... EASE* computers are a combination of standardized precision computer components built around the most versatile centralized control receptacle yet devised. Your EASE* computer can literally grow with the job as your requirements change or expand, with no loss of initial investment and very nominal added cost!

2. CONVENIENCE... EASE* offers centralized pushbutton control of problem solution, coefficient setting, and monitoring, plus the ultra-convenient EASE* patchboard – eliminates tedious manual pot setting, speeds set-up and solution time!

3. ACCURACY... chopper-stabilized dc amplifiers, 0.1% computing resistors and capacitors are standard, for high accuracy and stability. Servo-set coefficient pots can be set and adjusted under load to 0.01% accuracy. (If lower accuracy is permissible for your work, we can supply lower-cost units accordingly).

MEDIUM – includes control unit with 100 pots, 40 amplifiers, 14 electronic multipliers, function generator set-up unit with 1 pushbutton and 5 manual set generators, 2 servo multipliers, preset timer control unit, power supplies. Price range, $30,000 to $65,000.



SMALL – includes control unit with 50 pots, 30 amplifiers, 2 electronic multipliers, 10 initial condition voltage sources, power supplies. Price range, $12,000 to $25,000.

Want the most for your computer dollar? Investigate EASE* now! Our consulting service will supply sample solutions to your typical computer problems, recommend the type of EASE* computer best suited to your work. For complete information, please address Dep't G4

*TM for Electronic Analog Simulation Equipment by BERKELEY

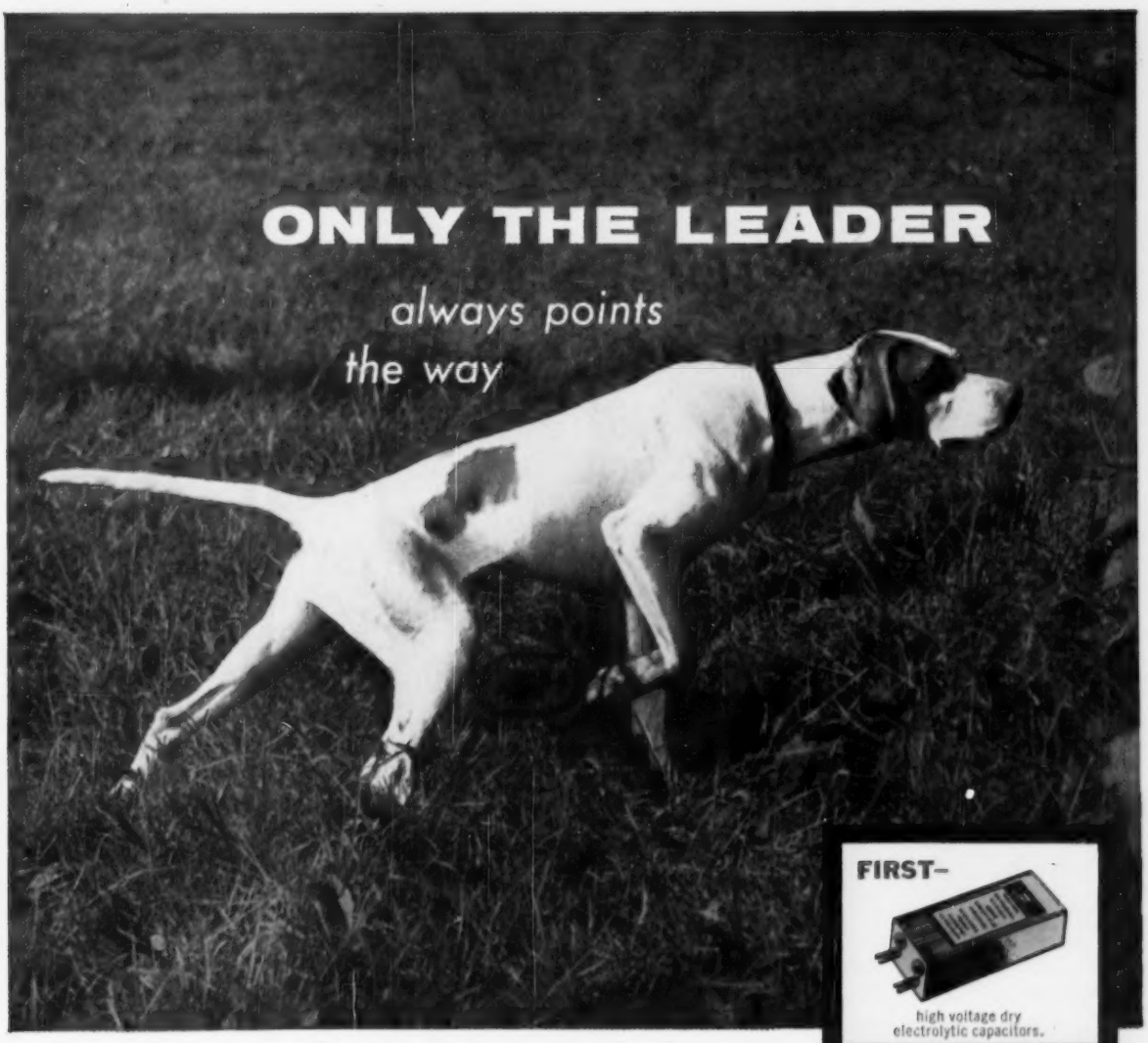
Berkeley *division*

84

BECKMAN INSTRUMENTS INC.
2200 Wright Avenue • Richmond 3, Calif.

ONLY THE LEADER

always points the way



FIRST–

high voltage dry electrolytic capacitors.

Pointing up progress in capacitor manufacturing is an old tradition at Cornell-Dubilier. Our list of new capacitor developments for every use began in 1910– with a record of consistent dependability and outstanding field performance, ever since.

FIRST–

capacitor to use anodic aluminum foil electro-chemically etched.

C·D...45 YEARS OF FAMOUS FIRSTS

Typical of these "famous firsts" are the three examples shown here . . . *proof* that whatever your capacitor requirements may be, your needs can be filled by C-D. Write to Cornell-Dubilier Electric Corp., Dept. K-46, South Plainfield, N. J.

FIRST–

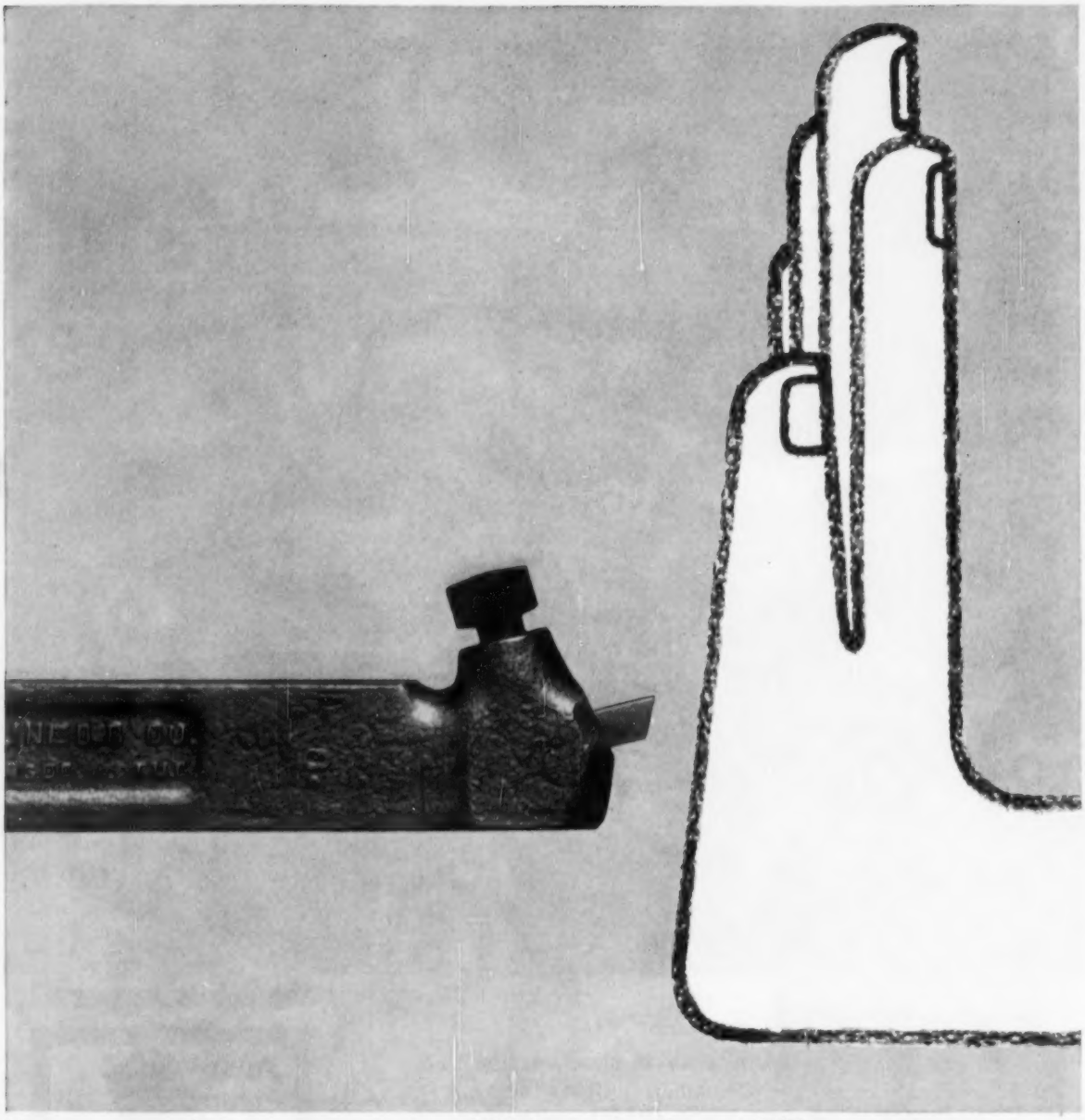
miniature, metal-cased electrolytic capacitors.

CONSISTENTLY DEPENDABLE

CORNELL-DUBILIER CAPACITORS

PLANTS IN SO. PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS.; PROVIDENCE AND HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD AND FUQUAY SPRINGS, N. C.; SUBSIDIARY, RADIART CORP., CLEVELAND, OHIO.

THERE ARE MORE C-D CAPACITORS IN USE TODAY THAN ANY OTHER MAKE



If you need to control machine operations, it'll pay you to use

Adlake mercury relays

Adlake relays require no maintenance whatever...are quiet and chatterless...free from explosion hazard. Dust, dirt, moisture and temperature changes can't affect their operation. Mercury-to-mercury contact gives ideal snap action, with no burning, pitting or sticking. Time delay characteristics are fixed and non-adjustable.

For more information about Adlake Relays, write The Adams & Westlake Company, 1171 N. Michigan, Elkhart, Indiana.

The Adams & Westlake Company

Established 1857 • ELKHART, INDIANA • New York • Chicago

the *original* and largest manufacturers of mercury plunger-type relays

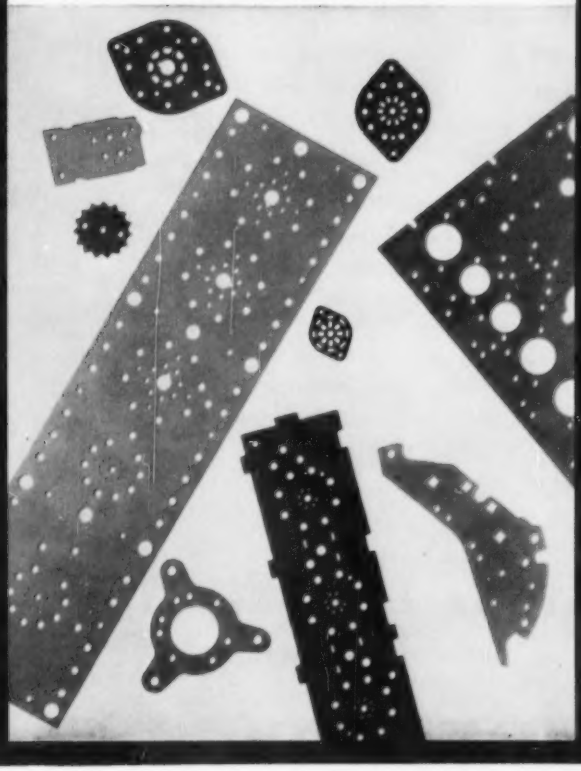
Adlake 99th year of serving the transportation, building and control industries

Textolite®

LOW COST—HOT OR COLD

Punching Grade Laminates

DESIGNED FOR AUTOMATIC PRODUCTION



CONSISTENTLY EQUALS OR EXCEEDS NEMA STANDARDS

G-E TEXTOLITE punching grade laminates have been designed to provide low-cost hot or cold punching laminates with excellent electrical and mechanical properties, geared to meet the requirements of today's high-speed production techniques.

These hot or cold punching grade laminates, engineered by General Electric, have been developed to meet the varied requirements of electrical and electronics manufacturers. Among the wide selections available are:

TEXTOLITE HOT PUNCH 2053 — High mechanical strength and electrical properties at low cost.

TEXTOLITE COLD PUNCH 11561 — Can be cold punched to ⅛" thick. Has good mechanical strength.

TEXTOLITE 11562 — Warm punch grade with a good combination of mechanical strength and electrical properties. NEMA grade P.

TEXTOLITE 11563 — Hot punch grade with stable electrical properties under humidity conditions. NEMA grade XXP.

TEXTOLITE 11564 — Best electronic insulation grade for high dielectric strength, low cold flow, and best humidity resistance. Hot punching NEMA grade XXXP.

These standard industrial grade laminates have a uniform color and appearance, and offer a new ease of fabrication. They CONSISTENTLY exceed NEMA values.

All TEXTOLITE punching grade laminates are available with copper foil on one or both surfaces, in flat sheets, for printed circuitry.

WHEN THE PROPERTIES HAVE TO BE RIGHT SPECIFY G-E TEXTOLITE

Progress Is Our Most Important Product

GENERAL ELECTRIC

Insulating Varnishes • Irrathene • Sealing and Filling Compounds • Mica & Mica Mat Insulation • Varnished Cloth and Tapes • Silicone Insulation • G-E Textolite Laminated Sheets, Rods & Tubes.

General Electric Company
Laminated and Insulating Products Department
Section EL - 4-6,
Coshocton, Ohio

( ) Please send me your TEXTOLITE INDUSTRIAL LAMINATE catalog M-CDL-245.

( ) Please have your representative call.

Name _____

Firm _____

Street _____

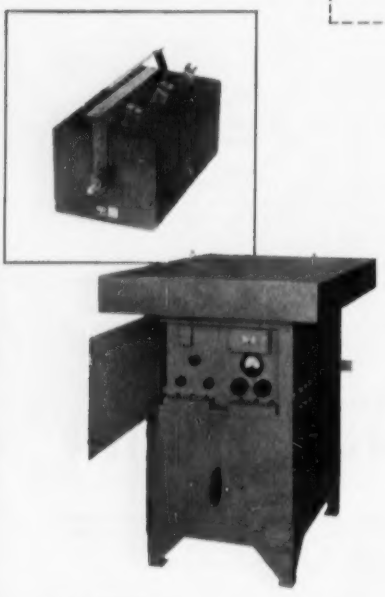
City _____ Zone _____ State _____

Aboard Uncle Sam's mighty new Flat Tops...

RADIO RECEPTOR SELENIUM RECTIFIERS

used in the power supplies for

BATTERY CHARGERS	SWITCHBOARDS



For complete dependability Ther's 10 KW battery chargers use Radio Receptor Selenium Rectifiers.

Huge aircraft carriers like the USS Saratoga and Forrestal demand complete reliability from a vast network of men, machines and components working together under all kinds of stress. Aboard these new fleet giants are power conversion units made by our customer, Ther Electric and Machine Works, Chicago, Ill. . . . and key component in each unit is a Radio Receptor Selenium Rectifier.

Because of their ruggedness, Radio Receptor rectifiers were selected to meet the severe service and environmental conditions requiring long life and dependability.

RRco. rectifiers constantly meet the stiffest requirements of government and industry. If *your* circuitry involves a problem in rectification, submit your specs to our engineering department. We'll be glad to make recommendations, without obligation of course. Write today to Dept. E-15.

Semiconductor Division

RADIO RECEPTOR COMPANY, INC.

In Radio and Electronics Since 1922

240 Wythe Avenue, Brooklyn 11, N. Y. • EVergreen 8-6000

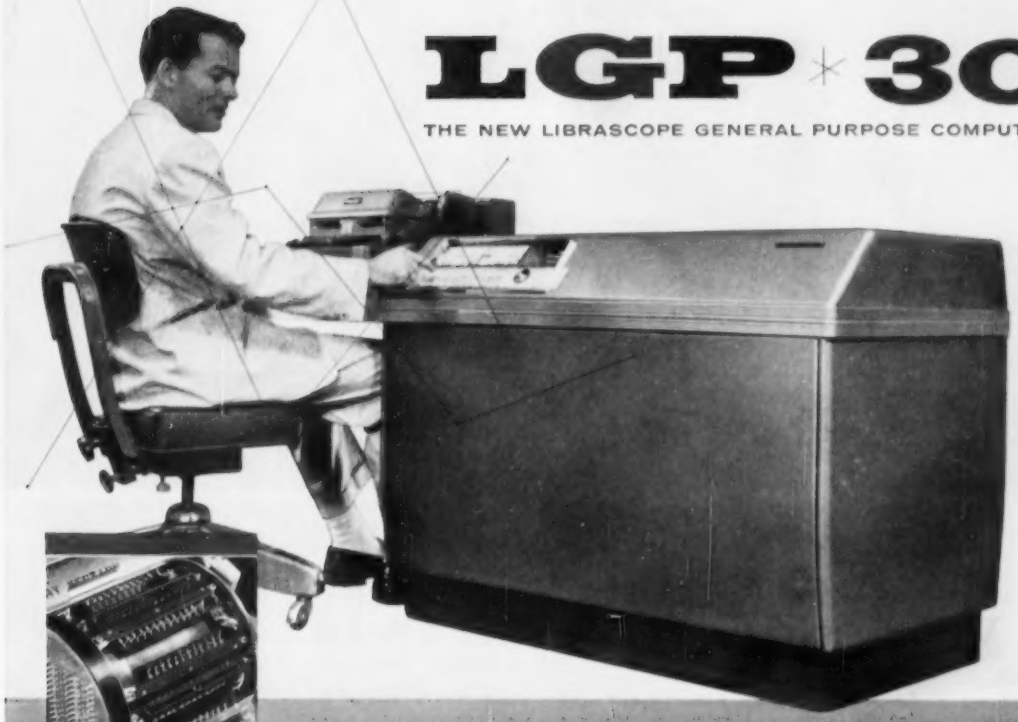
"Really Reliable"

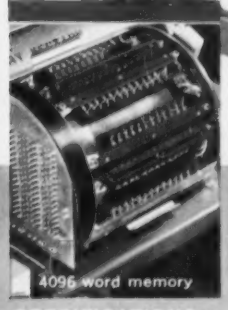
Radio Receptor Products for Industry and Government: Selenium Rectifiers • Germanium Diodes Thermatron Dielectric Heating Generators & Presses • Communications, Radar & Navigation Equipment

the new approach to large scale computations in research and development!

LGP-30

THE NEW LIBRASCOPE GENERAL PURPOSE COMPUTER





4096 word memory

SPECIFICATIONS:

Word length:
30 bits, and sign
Mode of Operation:
Serial, one address
Program Storage:
Internal
Access time:
8.5 ms av. 2 ms min.
Transfer time:
1 ms min, 17 ms max.
+ time: .26 ms
÷ × time: 17 ms
Power: 1500 Watts

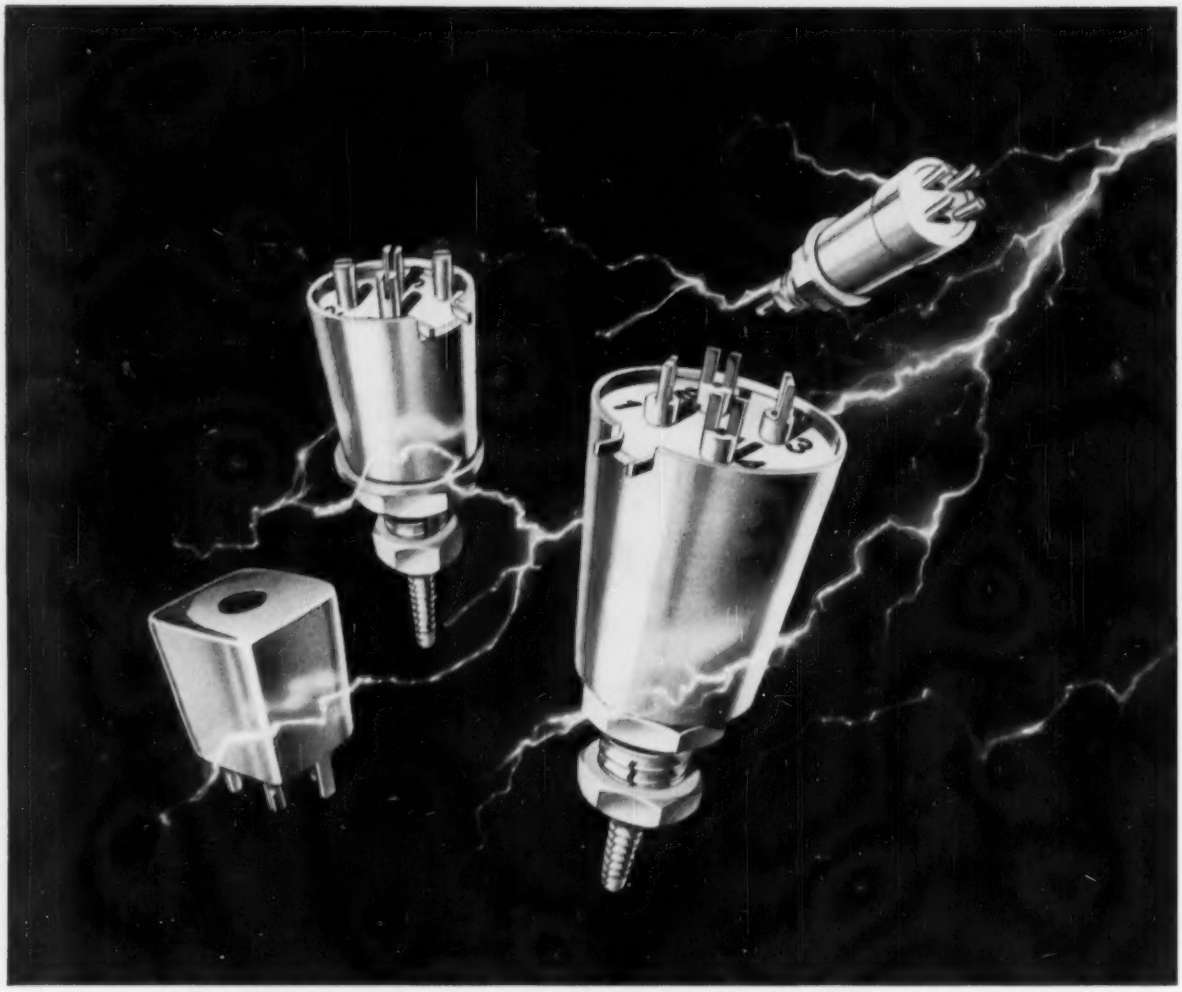
One word defines the "new approach" of the LGP-30...SIMPLICITY. *Operating Simplicity*...for the average engineer...made possible by the elimination of non-essential commands. Programming techniques are easily mastered. *Design simplicity*...that results in complete mobility. The LGP-30 may be operated from any 115 Volt AC outlet. *Service simplicity*...because fewer components, conservatively operated, mean less "time-out" for maintenance. And, too, the LGP-30 costs considerably less than any other general purpose computer—to buy and operate.

Write for brochure describing applications, operation and detailed specifications.

LIBRASCOPE

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

LIBRASCOPE, INC. • 808 WESTERN AVE. • GLENDALE, CALIFORNIA



Four sizes of shielded coil forms cover a wide range of design requirements. Dimensions when mounted, including terminals, are: LS-12 (square type for printed circuits), ½" x ½" x ½"; LS-9, 7/16" diameter x ½" high; LS-10, ¾" x 1 1/16"; LS-11, 1 1/16" x 1 1/32". Each form mounts by a single stud. Windings may be universal or wound to your specifications.

Where shock treatment doesn't work

CTC miniaturized shielded coil forms are highly shock resistant. With mechanically enclosed, completely shielded coil windings, they bring all the ruggedness and dependable performance you require for your "tight spot" applications — IF strips, RF coils, oscillator coils, etc.

CTC combines *quality control* with *quantity production* to supply exactly the components you need, in any amount. CTC *quality control* includes material certification, checking each step of production, and each finished product. And CTC *quantity production* means CTC can fill your orders for any volume, from smallest to largest.

For samples, specifications and prices, write to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass. On the West Coast contact E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, and 61 Renato Court, Redwood City, Cal.

TYPE SPC phenolic and ceramic printed circuit coil forms can be soldered after mounting. Phenolic forms: ¾" high when mounted, in diameters of .219" and .285". Ceramic forms: ¼" diameter, in mounted heights of ⅝" and 1 1/16", with 19/32" powdered iron core, and collars of silicone fibreglas. Forms come with threaded slug and terminal collar. Units mount through two to four holes, as required. Available as forms alone or wound as specified.

CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components
custom or standard

Want more information? Use post card on last page.

hp announces 2 all new OSCILLOSCOPES

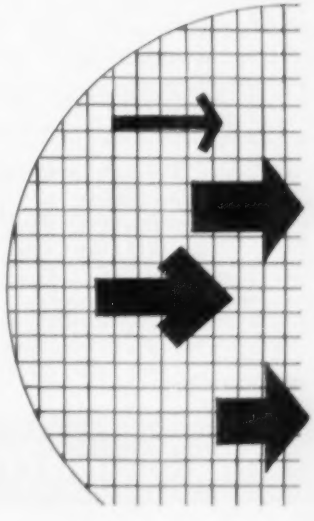
130A Low Frequency Oscilloscope
High sensitivity, dc to 300 KC.
Sweeps 1 μsec/cm to 15 sec/cm.

150A High Frequency Oscilloscope
Dc to 10 MC. Plug-in preamplifiers.
Sweeps 0.02 μsec/cm to 15 sec/cm.

A new standard of versatility, a new kind of operating simplicity, and real, long-term dependability—these characteristics make Models 130A and 150A the most outstanding oscilloscope values ever offered.

A totally different oscilloscope design philosophy is followed in these instruments. Specifications on the following pages indicate the broad measuring versatility that has been achieved. The instruments' greater convenience and dependability is inherent in such unique features as:

Circuits are unitized and can be isolated conveniently for testing or service
Most circuits are etched and mounted on translucent plastic for "see-through" serviceability. All circuits and tubes are completely accessible. Components are of highest quality.
Design is ultra-conservative, with circuits operated well below rated capacity. Controls are concentric, color-coded, grouped by function and much simplified. Sweep time selection is direct without interpolation or mental gymnastics. The high-frequency unit has a new "pen-sized" low capacitance probe with miniature clip-on alligator jaws, serving as a 10:1 voltage divider.



Both oscilloscopes have a "universal" automatic triggering system wherein one preset adjustment provides optimum triggering for almost all conditions.

Truly, with these two instruments, -hp- adds to the oscilloscope field the two new dimensions of CONVENIENCE and RELIABILITY!

150A High Frequency Oscilloscope

130A Low Frequency Oscilloscope

***-hp-* 130A Low Frequency Oscilloscope** is a versatile, accurate tool for laboratory and design work, yet its high gain, balanced input, simple operation and rugged construction make it a practical production instrument. The instrument also serves as a millivoltmeter or voltmeter.

Horizontal and vertical amplifiers are similar. Sensitivity is 1 mv/cm or 10 mv full scale deflection. Amplifiers have wide pass bands from dc to 300 KC. Input circuits are balanced on the five most sensitive ranges. Single ended input is also available, either ac or dc coupled. Both amplifiers are highly stable, and their gain may be standardized by an internal 1,000 cycle square wave source. These features, together with the instrument's precision input attenuator, permit use of the oscilloscope as a millivoltmeter or voltmeter accurate within 5%.

21 sweep times may be set and read directly. Horizontal sweeps are calibrated from 1 μsec/cm to 5 sec/cm. Accuracy is within 5%, and sweeps are highly linear.

In most cases, *-hp-* 130A will accept signals direct from a standard transducer without preamplification, presenting findings as a brilliant, high resolution trace visible under

BRIEF SPECIFICATIONS

-hp- 130A Low Frequency Oscilloscope

Sweep Range: 1 μsec/cm to 15 sec/cm.
Calibration: 21 sweeps: 1-2-5-10 sequence, 1 μsec/cm to 5 sec/cm. 5% accuracy.
Triggering: Internal, line voltage or external 2 v or more. Pos. or neg. slope, +30 to —30 v trigger range.
Preset Trigger: Optimum setting for automatic stable triggering.
Input Amplifiers: (Similar Vert. or Horiz. Amps). Sensitivity 1 mv/cm to 50 v/cm; 14 ranges plus continuous vernier. Pass band dc to 300 KC.
Amplitude Calibration: 1 KC square wave. 5% accuracy.
Price: $450.00.

-hp- 150A High Frequency Oscilloscope

Sweep Range: 0.02 μsec/cm to 15 sec/cm.
Calibration: 24 sweeps: 1-2-5-10 sequence, 0.1 μsec/cm to 5 sec/cm. 3% accuracy.
Triggering: Internal, line voltage or external 0.5 v or more. Pos. or neg. slope, +30 to —30 v trigger range.
Preset Trigger: Optimum setting for automatic stable triggering.
Horizontal Amplifier: Magnification 5, 10, 50, 100 times. Vernier selects any 10 cm part of sweep. Pass band dc to over 500 KC. Sensitivity 200 mv/cm to 25 v/cm.

Now, more than ever, hp means "Complete

last!

Real Dependability day after day!

hp OSCILLOSCOPES

Revolutionary Convenience
Broadest Possible Usefulness

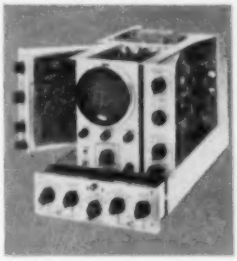
any light. A special feature of the instrument is the "universal" automatic triggering system — one preset condition which provides optimum triggering with almost any input signal.

-hp- 150A High Frequency Oscilloscope employs plug-in vertical preamplifiers. These include *-hp- 151A*, a high gain unit with 5 mv/cm sensitivity and frequency response from dc to 10 MC; and *-hp- 152A*, a dual amplifier permitting two phenomena to be presented on the CRT simultaneously.

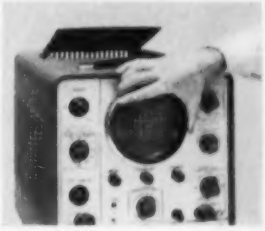
Model 150A's vertical amplifier has good transient response and less than 0.035 μsec rise time, pass band dc to 10 MC. A 0.25 μsec delay line permits viewing the leading edge of the signal triggering the sweep.

A direct reading panel control selects any of 24 calibrated sweeps. The instrument includes the "universal" triggering adjustment providing optimum triggering for almost all conditions. Model 150A also features a single-shot sweep circuit which, after "firing", remains locked out until rearmed.

The instrument's horizontal amplifier provides sweep magnification of 5, 10, 50 and 100 times. "Reminder" lamps indicate when the circuit is in use, or the combination of sweep time and magnification exceeds the maximum calibrated sweep time. The amplifier's sensitivity is 50 mv/cm to 25 v/cm, pass band dc to 500 KC.



Unitized construction. Basic circuit elements assembled as separate units. Translucent mounting boards, hinged sub-chassis for maximum accessibility.



15° turn removes bezel for filter replacement, or quick CRT interchange. Bezel provides solid camera base. Top access door permits direct CRT connections.

Voltage divider probe. New 10 μμf capacitance probe has exclusive clip-on nose; 10 megohm input impedance.

Vertical Amplifier: Pass band dc to 10 MC. Optimum transient response and rise time less than 0.035 μsec. Signal delay of 0.25 μsec permits leading edge of triggering signal to be viewed.

Amplitude Calibration: 18 calib. voltages, 2-5-10 sequence, 0.2 mv to 100 v peak-to-peak. Accuracy 3%. Approx. 1 KC square wave, rise and decay approx. 1.0 μsec.

Prices: *-hp-* 150A High Frequency Oscilloscope, $1,000.00.
-hp- 151A High Gain Amplifier, $100.00.
-hp- 152A Dual Channel Amplifier, $200.00.

Data subject to change without notice. Prices f.o.b. factory.

GET THE COMPLETE STORY! SEE YOUR -hp- REPRESENTATIVE OR WRITE DIRECT!

hp hp hp

HEWLETT-PACKARD COMPANY
3636A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U. S. A.
Field engineers in all principal areas
Cable "HEWPACK" • DAVENPORT 5-4451

Coverage" in electronic test instruments!

"Reliability where it counts,"

says C. C. Harris,
Vice President and Chief Engineer,
Tropical Radio Télegraph Company,
about the Westinghouse . . .

WL-5736 POWER TUBE

"We have been using the WL-5736 for seven years," says Mr. Harris. "We have found it to be highly reliable and to give long life. Tropical Radio Telegraph Company requirements are strenuous, especially in hot, humid, tropical climates. Our radio network is vital to Middle-American tele-communications service, and the WL-5736 has given us reliability where it counts."

Reports from dozens of other users echo the experience of Tropical Radio Telegraph. For the WL-5736 has long set the standard of excellence in communications and RF heating equipment of all types.

Wherever you need 2.5 kilowatts RF in a small, dependable package, you too will find its performance unbeatable.* Write today for full design data. Commercial Engineering Dept., Westinghouse Electric Corporation, Elmira, N. Y. **ENGINEERS!** For challenge, security, growth potential, investigate career opportunities now being offered by Westinghouse Electronic Tube Division. Write Technical Placement Director today.

6ET-4106

**Where cooling by low-pressure blower is desirable, specify the new WL-6623 with extra-large radiator and "flying leads."*

YOU CAN BE SURE...IF IT'S Westinghouse **RELIATRON® TUBES**

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, N. Y.

Otis

ELECTRONIC DIVISION

from the 102-year world leader in elevatoring . . .

THE BRAINS

the brawn

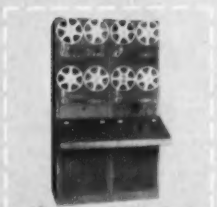
THE VISION

the skills

INTEGRATED *for* defense electronics

THE EXPERIENCE

the tools



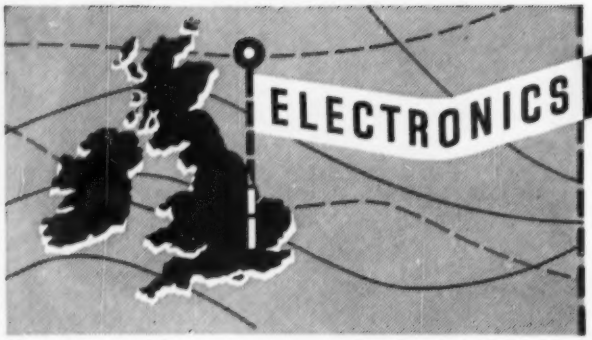
OTIS . . . a proven source for research, development, manufacture and maintenance of large-scale equipment and systems in the fields of:

- missile guidance and control
- gunfire control
- radar and counter measures
- simulators and training aids
- communication
- special electronic devices
- computers
- ultrasonics
- servomechanisms
- magnetic amplifiers
- testing instrumentation
- electro-mechanical components

For engineering achievements, rely on engineering-minded management—rely on Otis.
Write on your letterhead for 32-page history and facilities report.

OTIS ELEVATOR COMPANY
26 EVERETT STREET, BROOKLYN 5, N. Y.
ELECTRONIC DIVISION

appropriateness.



The British Electronics Industry is making giant strides with new developments in a variety of fields. Mullard tubes are an important contribution to this progress.

EF86

Another Mullard contribution to high fidelity

The Mullard EF86 audio frequency pentode is one of the most widely used high fidelity tubes in Britain today. It has been adopted by the leading British manufacturers whose sound reproducing equipment is enjoying increasing popularity in the United States and Canada.

The marked success of this tube stems from its high gain, low noise and low microphony characteristics.

By careful internal screening, and by the use of a bifilar heater, hum level has been reduced to less than 1.5μV. Over a bandwidth of 25 to 1,000c/s equivalent noise input approximates 2 μV.

When operated below 1,000c/s, internal resonances of the EF86 are virtually eliminated. Even at higher frequencies chassis and tube socket damping are usually sufficient to make vibration effects negligible.

Supplies of the EF86 are now available for replacement purposes from the companies mentioned here.

Principal Ratings

Heater	6.3V, 0.2A
Max. plate dissipation	1W
Max. screen dissipation	0.2W
Max. cathode current	6mA

Characteristics

Plate voltage			250V
Screen voltage			140V
Grid voltage			−2V
Plate current			3mA
Screen current	0.6mA	Transconductance	1800 μmhos

Base

Small button noval 9-pin

Supplies available from:—

In the U.S.A. International Electronics Corporation,
Dept. E4, 81 Spring Street, N.Y.12,
New York, U.S.A.

In Canada Rogers Majestic Electronics Limited,
Dept. IH, 11-19 Brentcliffe Road,
Toronto 17, Ontario, Canada.

Mullard

ELECTRONIC TUBES

used throughout the world

MULLARD OVERSEAS LTD., CENTURY HOUSE, SHAFTESBURY AVE., LONDON, ENGLAND

Mullard is the Trade Mark of Mullard Ltd. and is registered in most of the principal countries of the world.

MEV 34

INDUCTROLS*

appropriateness.

re·li′a·ble (rē·lī′*ə*·b'l), *adj.* Suitable or fit to be relied on; worthy of dependence or reliance.

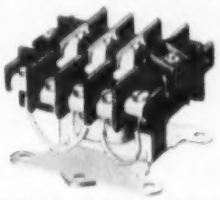
re·l

This one definition sums up what we at Leach feel is the most important single thing we can build into a relay, be it a simple motor-starter type or a complex, hermetically sealed unit destined to help guide a missile. It's the starting point of our design thinking, the basis for all manufacturing and quality-control practices.

Reliability of any component is basically the *probability* of its successful operation during a given task. And in a relay, there's no halfway operation . . . it's either working or useless. So we say only this: whatever your relay needs, look to Leach *first;* then *test* Leach against any make on the market. You'll see why, for years, it has been a habit throughout industry to specify LEACH where complete system reliability is a must.

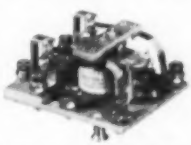
LEACH . . . standard of relay quality for over 30 years . . . offers a broad line for industrial, electronic and aircraft use . . . *and,* special types on order.

commercial controls and contactors

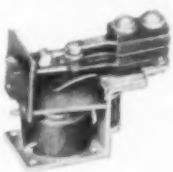


hermetically sealed aircraft types

radio and high-frequency relays

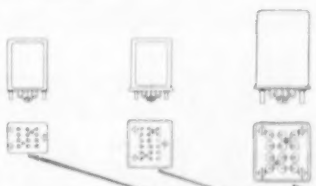


motor starting snap-action types



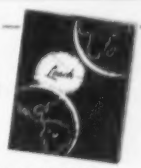
This is NEWS at LEACH

A new group of **system designed** relays, designed to insure **system** reliability in electronic, aircraft and missile work. Their square shape makes it possible to place 20% more relays in a given space . . . they have optional lead arrangements . . . are hermetically sealed, shock-resistant, can operate **dependably** at 120°C ambient. Complete specifications available on request.



	9220	9226	9230
Contact arrangement	4PDT	6PDT	4PDT
Operating voltage	18-30 VDC	18-30 VDC	18-30 VDC
Contact rating at 28 VDC Resistive Inductive	 5 amp 1.5 amp	 5 amp 1.5 amp	 10 amp 7 amp
Coil resistance	250 ohms	200 ohms	150 ohms
Duty	Continuous	Continuous	Continuous
Weight	.25 lb.	.25 lb.	.5 lb.
Case dimensions, inches	1.3x1x1.7	1.5x1.5x1.7	1.7x1.7x2.6

Send for the latest Leach Relay Catalog . . . your best starting point when selecting any relay.



LEACH CORPORATION / LEACH RELAY DIVISION

5915 AVALON BLVD., LOS ANGELES 3, CALIFORNIA

DISTRICT OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES OF U. S. AND CANADA

INDUCTROLS* profitable industrial voltage regulation

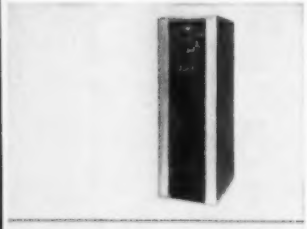
RADAR

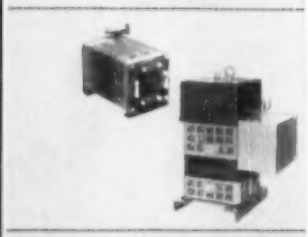
COMMUNICATIONS

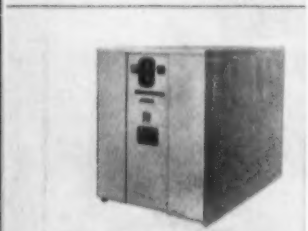
COMPUTERS

Performance of electronic equipment depends on proper voltage

Help assure customer satisfaction; Install G-E Inductrols* on your equipment







A G-E INDUCTROL FOR EVERY NEED

AUTOMATIC INDUCTROL—Applied where constant voltage is desired, as on radar equipment, electronic computers, induction heaters, rectifiers, welders. Available for single- or three-phase circuits, 600 volts and below.

HAND- OR MOTOR-OPERATED INDUCTROL—Provide stepless variable-voltage output over any desired range. For testing, heating, or illumination control, and similar applications. Single- and three-phase—600 volts and below.

INDUCTROL POWER PACK—This is a load center unit substation for a-c power and lighting service. Unit includes a transformer, Inductrol, circuit breakers, and distribution panel board. Generally applied in three-phase circuits—600 volts and below—indoor service.

Yes, even small variations in the voltage supplied to sensitive electronic equipment can result in inaccurate operation, inefficiency, and drastically reduced life (a 10% overvoltage can reduce vacuum tube life by *70%!*). However, many users do not realize they have a voltage problem, and when their electronic equipment fails to operate properly, the reputation of the original equipment manufacturer usually suffers.

G-E Inductrols (induction voltage regulators) provide a reliable, economical means of maintaining rated utilization voltage ***without introducing harmful waveform distortion.*** Installed on your equipment, G-E Inductrols assure proper operation even under adverse voltage conditions. Inherent high short-circuit strength and elimination of brushes make G-E Inductrols a simple, economical solution to voltage problems.

For complete information and application assistance, contact your nearest General Electric Apparatus Sales Office, or write Section 425-2, General Electric Company, Schenectady 5, N. Y.

*G-E Induction Voltage Regulators

Progress Is Our Most Important Product

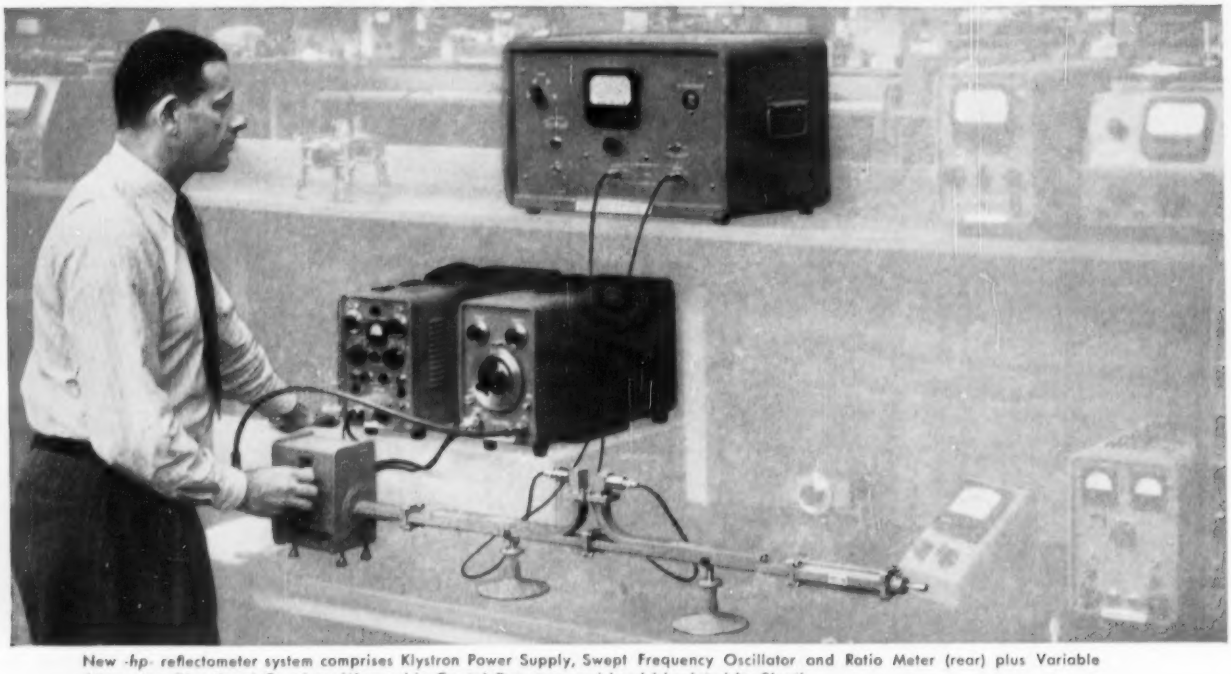
GENERAL ELECTRIC

TUNING FORK RESONATORS • THE ULTIMATE IN PRECISION AUDIO FREQUENCY CONTROL

PHONE OR WRITE *for complete information regarding component type Tuning Fork Resonators, or variously packaged Tuning Fork Frequency Standards.*

PHILAMON LABORATORIES INC.
90 Hopper Street, Westbury, Long Island, N. Y. **ED***gewood* **3-1700**

IT'S HERE! A fast, accurate wide-range microwave



New -hp- reflectometer system comprises Klystron Power Supply, Swept Frequency Oscillator and Ratio Meter (rear) plus Variable Attenuator, Directional Couplers, Waveguide Crystal Detectors and Load (simulated by Short).

SPECIFICATIONS

-hp- 416A RATIO METER

METER PRESENTATION: (a) As a Reflectometer: Percent reflection (magnitude of reflection coefficient). Four ranges, full scale values of 100%, 30%, 10%, 3% reflection. (1.00, 0.30, 0.10, 0.03 reflection coefficient.) (b) As a VSWR Indicator Voltage Standing Wave Ratio. Four ranges, 1 to 3, 3 to 10, 10 to 30, 30 to 100 VSWR. (c) Decibel scale for either application: 0 to 10 db, 40 db total, ranges spaced exactly 10 db.
ACCURACY: ±3% of full-scale value for 20 to 1 range of incident or reference r-f power.
CALIBRATION: Square-law, for use with Crystal Detectors or barretters.
FREQUENCY: 1,000 cps. ±40 cps.
INPUT VOLTAGE: Incident or Reference Channel: 3 mv to 100 mv rms. Reflected or Probe Channel: 0.3 mv to 100 mv rms. (Square-wave or sine-wave).
INPUT IMPEDANCE: Approximately 75 K ohms.
EXCESS COUPLER LOSS: Provision made for increasing sensitivity of the Incident Channel by 10 db for reflectometer setups employing couplers with different coefficients. Under certain circumstances, accuracy can be improved by this procedure.
OUTPUT: Connectors for oscilloscope and recorder.
ADJUSTMENTS: "Set to Full Scale" control for initial calibration with 100% reflection, or at VSWR peak.
INTERNAL CHECK: "Eye" tube continuously monitors input amplitude (and frequency indirectly) to assure proper operating range for instrument and for crystal detectors.
PRICE: $365.00.

-hp- 670HM shf OSCILLATOR

FREQUENCY RANGE: 7.0 kmc to 10.0 kmc.
OUTPUT POWER: Approximately 10 mw entire frequency range.
ATTENUATOR RANGE: 100 db.
MODULATION: (a) Grid Modulation for optimum swept-frequency performance. (b) Reflector Modulation for optimum single-frequency performance. Modulating signals must be provided from external source (normally the -hp- 717A Power Supply). Pulses as short as 3 microseconds can be produced.
MECHANICAL SWEEP: Fully adjustable to cover any 10% or larger portion of the 7.0 kmc to 10.0 kmc spectrum. Sweep rate approximately 12 to 60 complete cycles per minute depending on swept frequency range. (Special sweep rates available at additional charge.)
SWEEP VOLTAGE PROVIDED: Linear voltage proportional to mechanical sweep. (Approximately 100 volts change provided for 7 to 10 kmc swept frequency range.)
PRICE: $1175.00

-hp- 717A KLYSTRON POWER SUPPLY

BEAM SUPPLY:
VOLTAGE RANGE: 800 to 1,000 volts.
CURRENT: 25 ma, maximum.
REGULATION: (a) For constant load, less than ±0.1% output voltage change for ±10% variations from 115-volt line. (b) Less than ±1% output voltage change for output currents from 0 to 25 ma.
HUM: Less than 10 millivolts.
REFLECTOR SUPPLY:
VOLTAGE RANGE: 0 to 600 volts in 3 ranges.
CURRENT: 1 ma maximum; source resistance approximately 300 K ohms.
REGULATION: For constant load, less than ±0.05% change for ±10% variations from 115-volt line.
HUM: Less than 10 millivolts.
SQUARE WAVE MODULATION: (a) Amplitude adjustable 0 to 60 volts peak-to-peak. (b) Rise and decay times less than 10 microseconds. (c) Frequency adjustable from 400 to 1,000 cps.
SINE WAVE MODULATION FOR FM'ing: (a) Amplitude adjustable from 0 to 300 volts peak-to-peak. (b) Frequency: line voltage frequency. (c) Oscilloscope horizontal sweep voltage: 15 volts peak-to-peak, phase adjustable ±45° with respect to modulating voltage.
EXTERNAL: Terminals available for applying external modulating voltage. System will pass 3 microsecond pulses.
GRID SUPPLY:
VOLTAGE RANGE: 0 to +30 volts, open circuit, referred to cathode potential.
SQUARE WAVE MODULATION: (a) Amplitude adjustable 0 to 60 volts peak-to-peak. (b) Rise and decay times less than 10 microseconds. (c) Frequency adjustable from 400 to 1,000 cps.
EXTERNAL: Terminals available for applying external modulating voltage. System will pass 3 microsecond pulses.
FILAMENT SUPPLY: 6.3 volts ac., 2 amps.
PRICE: $375.00.

-hp- X421A CRYSTAL DETECTOR

FREQUENCY RANGE: 8.2 kmc to 12.4 kmc.
SENSITIVITY: Approximately 1 mv/0.01 mw (average value).
VSWR: Less than 1.5 entire frequency range.
FREQUENCY RESPONSE: Flat within ±2 db entire frequency range.
PRICE: $75.00. (Includes 1N26 Silicon Diode and matched video-load resistor.)

-hp- 752 DIRECTIONAL COUPLERS

COUPLING: X752C — 10 db coupling
X752D — 20 db coupling
WAVEGUIDE SIZE (in.): 1 x ½
FREQUENCY RANGE (kmc): 8.2 - 12.4
DIRECTIVITY: Better than 40 db full range.
PRICE: $100.00

All prices f.o.b., Palo Alto, California
Data subject to change without notice

hp ELECTRONIC TEST INSTRUMENTS for

reflectometer system for impedance measurement

Reflection coefficient or SWR measured instantly over wide frequency range

Direct, continuous swept-frequency oscilloscope presentation

Higher accuracy than slotted lines for single frequency measurement

Ends tedious point-by-point checking; system unaffected by amplitude variation

Ideal for fast production checks, system alignment, laboratory work checking waveguide components, antenna and rotary joint performance, etc.

Now -*hp*- offers a fast, accurate and *practical* reflectometer system that eliminates long hours of engineering previously required for microwave impedance measurements. The system provides direct meter readings of reflection coefficient, and is so simple to operate it can be used by non-technical personnel. An output is also available for oscilloscope or recorder presentation. The system eliminates the need for measuring forward and reverse power separately, and does away with tedious adjustments to correct for source amplitude variations. At present the equipment is available for X band operation only but components for other frequency ranges will be offered soon. The system includes several completely new -*hp*- instruments:

-hp- 416A Ratio Meter automatically combines forward and reverse signals and displays their ratio directly, irrespective of amplitude variations. Reflection coefficient may be read directly on the front panel meter. A signal at a rear terminal is provided to operate an oscilloscope or recorder. Model 416A contains an rf power monitor indicating proper power level. Obtainable accuracy for single frequency measurement is ±0.005 reflection coefficient; for swept frequency measurement, ±0.015 reflection coefficient.

Model 416A may also be used to measure SWR in connection with slotted lines. A reference voltage from the system power source applied to the ratio meter eliminates error due to amplitude variation.

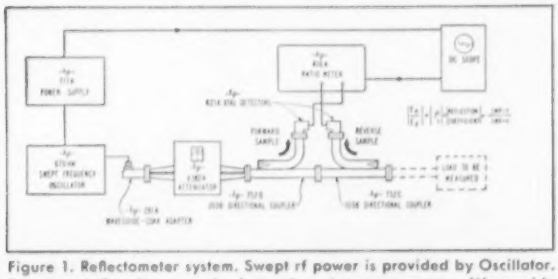


Figure 1. Reflectometer system. Swept rf power is provided by Oscillator. Directional Couplers sample forward and reverse power. Waveguide Detector Mounts terminating both Couplers demodulate power and present a 1,000 cps signal to Ratio Meter. Oscilloscope presents continuous visual study of reflection coefficient over the swept frequency range.

-hp- 670HM Swept Frequency Oscillator operates over a frequency range of 7 to 10 KMC. It may be manually tuned or motor driven to sweep any portion of this frequency band automatically. Sweep is at a velocity which is constant and sufficient to insure a clear trace on a long-persistence cathode ray oscilloscope. -*hp*- 670HM has a direct-reading frequency dial, and a waveguide-beyond-cutoff attenuator. It is normally grid modulated for sweeping, but also has reflector modulation for both fm and pulsed output. The oscillator requires an external power supply.

-hp- 717A Klystron Power Supply provides 800 to 1,000 volts beam voltage with regulation better than 0.1%, and 0 to 600 volts reflector voltage with regulation better than 0.05%. Model 717A also includes square wave modulation for both grid and repellor, as well as sine wave modulation for fm'ing. It is specifically designed as a companion instrument to -*hp*- 670HM.

-hp- 752 Series Directional Couplers are high directivity units consisting of two waveguides joined on their broad faces. Coupling is obtained through a series of precisely matched, graduated holes. In the system pictured, two couplers (with 10 db and 20 db directivity respectively) are joined back to back. Power flow is then as indicated in Fig. 1.

-hp- 421A Waveguide Detectors have square-law characteristics and demodulate the rf signal for use by -*hp*- 416A Ratio Meter.

Brief specifications of major instruments in the -*hp*- reflectometer system are given here. Complete specifications on all instruments in the system will be sent on request. For a comprehensive discussion of reflectometer measurements with these instruments, see -*hp*- Journal, Volume 6, Number 1-2, or write direct.

HEWLETT-PACKARD COMPANY

3150A Page Mill Road • Palo Alto, California, U.S.A.

Cable: "HEWPACK"

Field Representatives in all principal areas

COMPLETE COVERAGE, HIGHEST QUALITY

Phelps Dodge modern fits new

First for Lasting Quality—from Mine to Market!

enamel wire exacting coil designs!

New processes and controls assure uniform quality:

1. **Uniform over-all size—for uniform windings.**
2. **Uniform softness with high tensile strength for tighter windings, reduced breakage.**
3. **Uniform spooling, larger packages for lower-cost windings.**
4. **Uniform property balance for good flexibility, solvent resistance and dielectric strength.**

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

Meters tell the tale but SPECIAL ELECTRICAL ALLOYS do the work

"Steelmaker to the Electrical Industry" is a title we have earned the hard way . . . by the sweat of research and pioneering development. In this modern world of gauges and instruments, of automation, electronics and atomics, the heart of the design is so often some silicon steel, high-permeability alloy, or other special electrical material that we produce. ● When *you* need a steel to do what ordinary steels cannot do—whether electrically or in resisting corrosion, heat, wear or great stress, call on us. *Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.*

STEELMAKERS to the Electrical Industry

Allegheny Ludlum

Warehouse stocks of AL Stainless Steels carried by all Ryerson plants

® WSW 6042

AL
STEELS FOR THE ELECTRONIC AGE

Write for **"MAGNETIC MATERIALS"**

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free.

ADDRESS DEPT. E-76

Want more information? Use post card on last page.

Sea sentinels

A key factor in the nation's defense is the Air Force's oceanic chain of Texas Towers now under construction. For communicating their findings, these radar stations—like those in the continental North—rely upon the forward propagation tropospheric scatter systems developed by REL.

In this case, REL has supplied the transmitter exciters and diversity receivers which make possible long range tower-to-shore and shore-to-tower communication without booster stations. Performance and dependability quite naturally exhibit REL's world-famed standard of excellence.

Ninth in a series describing REL versatility

Type 796T transmitter exciter

Type 834 receiver with type 847 diversity combiner

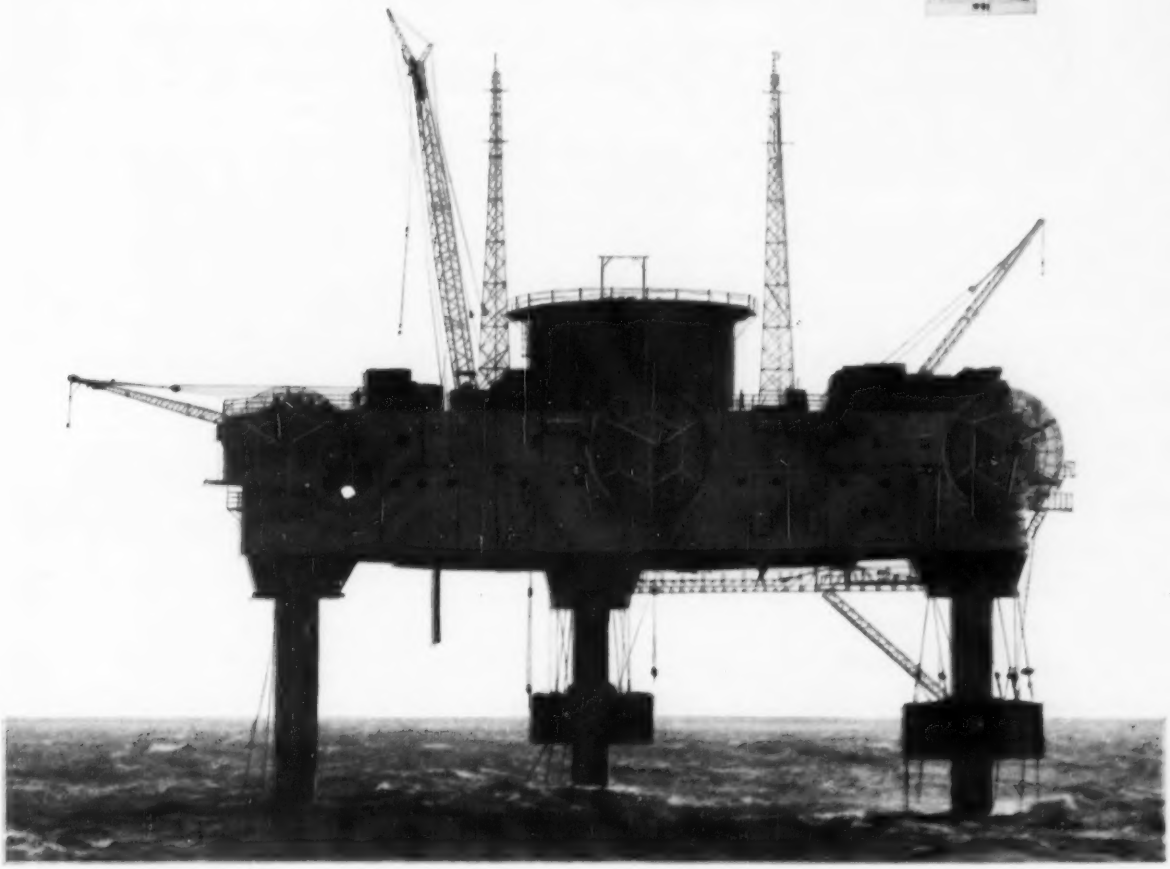
REL

Radio Engineering Laboratories·Inc.

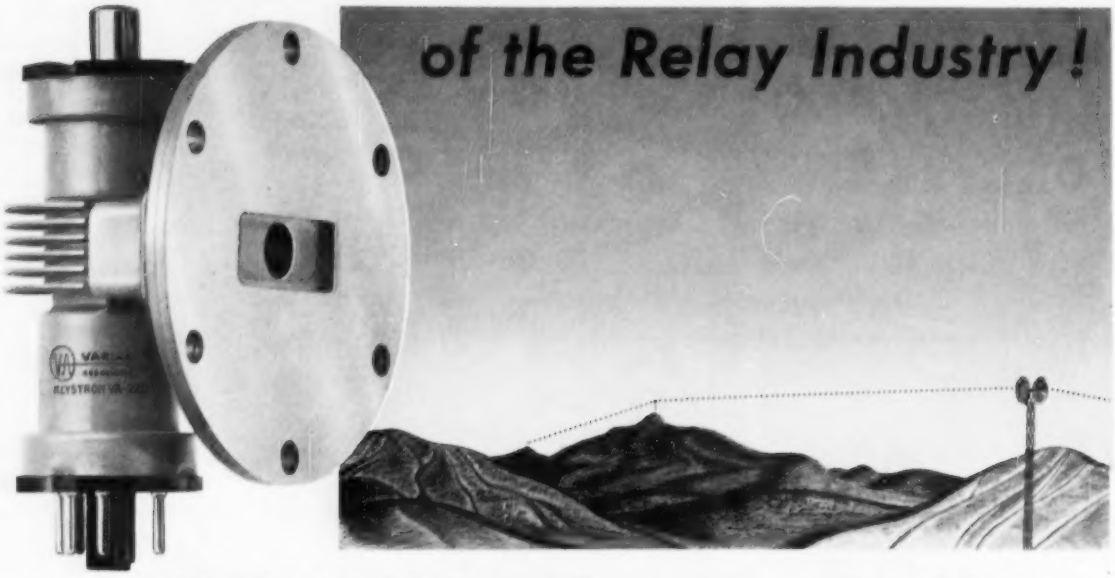
36-40 37th St · Long Island City 1, N Y

STillwell 6-2100·Teletype: NY 4-2816

Canadian representative: AHEARN & SOPER CO · BOX 715 · OTTAWA



NOW...the accepted standard of the Relay Industry!



Varian's high performance relay klystron

It's the VA-220, another outstanding example of Varian design leadership . . . research and product engineering that brings you optimum reliability plus performance characteristics unsurpassed by any other relay klystron.

UNSURPASSED FOR EVERY RELAY APPLICATION

Microwave relay system designers and equipment buyers have long known that Varian relay klystrons are unmatched for frequency stability, power to override noise, reliability and long life. The VA-220 gives you performance that even exceeds the high standards set by Varian X-26 klystrons . . . at half the cost.

In the 6000 - 8000 megacycle band, VA-220 klystrons will consistently outperform all others. Here are six reasons why this sensational new klystron is your best buy for all relay applications:

THESE ADVANTAGES MEAN TOP PERFORMANCE

- **Greater Power**—VA-220 high power klystrons are conservatively rated. They will deliver **more** than rated power **without** failure.
- **Greater Frequency Stability**—VA-220 klystrons have negligible frequency drift.
- **Greater Uniformity**—Varian mass production techniques **assure** uniformity—every klystron is as reliable as a nut and bolt.
- **Longer Life**—VA-220 klystrons can be operated at full power for thousands of hours.
- **Less Distortion, Less Noise**—FM distortion and inherent noise are negligible—60 db below a 1-megacycle deviation.
- **Lower Cost**—VA-220 klystrons cost **far** less than any other relay klystron with comparable performance characteristics.

TYPE	FREQUENCY RANGE	RESONATOR VOLTAGE	POWER OUTPUT	BANDWIDTH	MODULATION SENSITIVITY
VA-220*	5925 - 7425 mc	750 v	1.2 watts	35 mc	375 kc/v
VA-220 B, C, D, E and F each cover a frequency range of approximately 300 mc					

FOR COMPLETE SPECIFICATIONS

. . . and technical data on the VA-220 and other Varian klystrons, write to the Varian Application Engineering Department today.

THE MARK OF LEADERSHIP

VARIAN associates

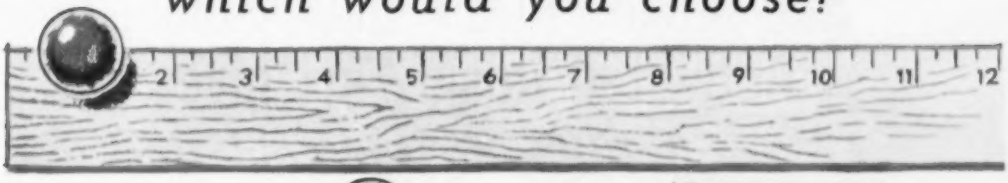
PALO ALTO 1, CALIFORNIA

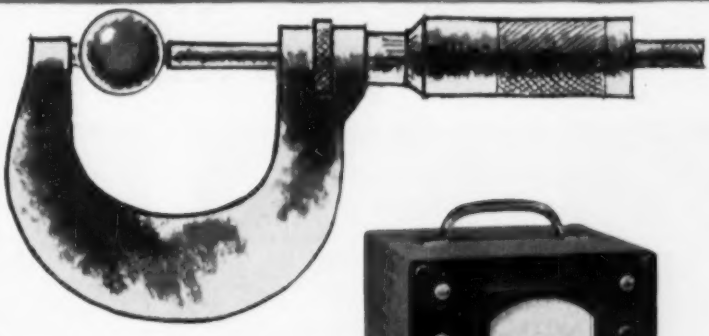
Representatives in all principal cities

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, R. F. SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

TO MEASURE A PRECISION BEARING . . .

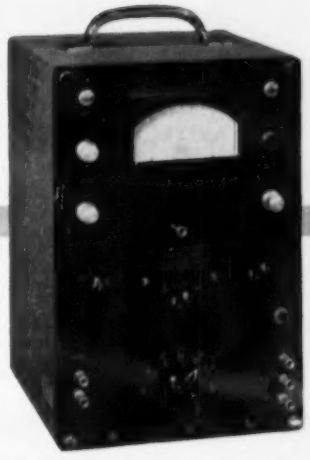
which would you choose?





• The micrometer, naturally. Engineers designing precision electronic equipment make the same choice when they select SIE test instruments . . . that's why you'll find SIE's Model M-2 Oscillator and R-1 Voltmeter in many of the country's leading laboratories.

The M-2 Oscillator covers the audio, geophysical and ultrasonic range with excellent stability and extremely low distortion. **The Model R-1 Voltmeter,** with its flat response D-C Amplifier and extremely wide range, provides a matching teammate for accurate circuit analysis.



Where precise measurements are required . . .
SIE precision instruments are ESSENTIAL.

SIE Model M-2 OSCILLATOR

- Range: 1 to 120,000 cycles per second.
- Dial Calibration: within 1½% ±.1 cycle per second.
- Amplitude Stability: within ½ db. throughout range.
- Frequency Stability: within .1% after warmup.
- Harmonic Distortion, Hum and Noise: less than .2% at any level within audio range.
- Output: 20 volts at 20 milliamperes.

/ $425

SIE Model R-1 VOLTMETER

- DC: 1 mv. to 1000 volts full scale, accurate to 1½%.
- AC: 1 mv. to 1000 volts full scale, accurate to 3%.
- Balanced D-C Amplifier: flat to 100 kc, gain of 200x.
- Ohms: 0 to 500 megohms, with scale expansion.
- Distended DC Scales: for reading changes as small as one part in 10,000.

/ $620

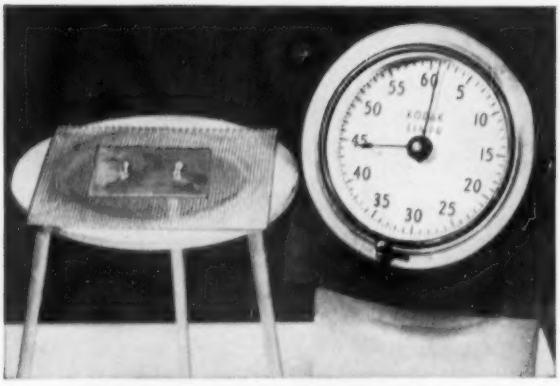
SIE

SOUTHWESTERN INDUSTRIAL ELECTRONICS COMPANY *Industrial Instruments Division*
P. O. Box 13058 · 2831 Post Oak Road · Houston 19, Texas

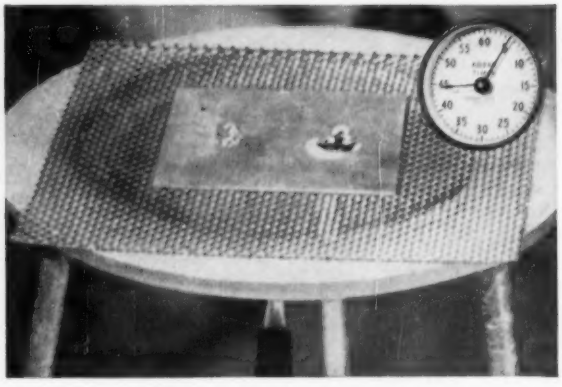
Make this test yourself

and prove "Dutch Boy" Solder with Activated Rosin Flux* gives you

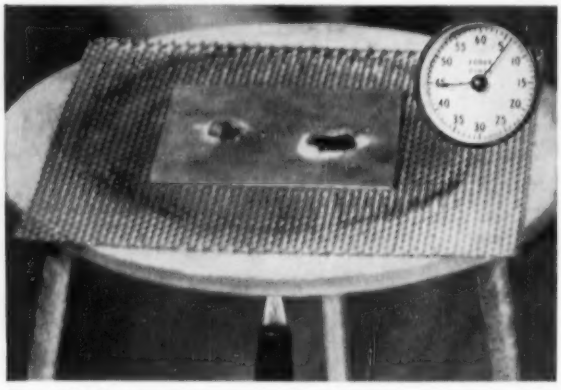
50-100% faster soldering
50-60% more soldering "mileage"



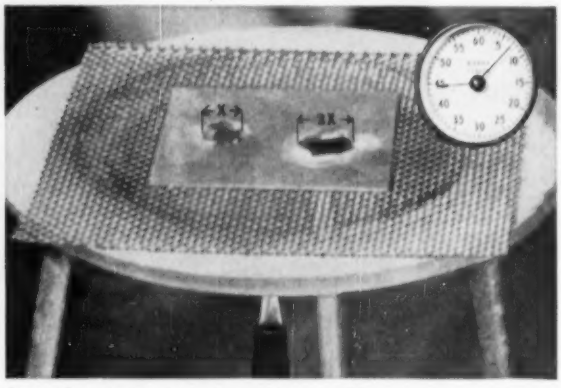
Set test up like this! Place one-inch, doubled-up samples of ordinary rosin core and "Dutch Boy" *activated* rosin core solders on sheet of clean copper. (In these pictures, "Dutch Boy" sample is on your right.)



Center torch flame under the copper sheet! Notice how the flux runs out — "Dutch Boy" a little ahead. All at once, the "Dutch Boy" sample melts, the special flux helping to conduct heat through the solder.



Keep the heat on! A second or so later, the ordinary solder starts to melt. But look at the "Dutch Boy" sample. See how it has spread . . . thanks to superior wetting properties of the activated flux.



Stop the clock when the ordinary solder reaches maximum spread (two to four seconds). No need to measure. "Dutch Boy", with *activated* flux, covers over 60% more area.

*"Dutch Boy" rosin core wire solder with activated flux sold under trade names "NUAX" and "HYAX".

Look to National Lead for . . .

1. **Solders and fluxes** . . . all "standard" and "specification" types, forms, and pre-forms.
2. **Solder application help** . . . National Lead specialists in metal-joining jobs are at your service . . . literally. They have the "backing" of plant laboratories all over the country and of the central Research Labs in New York.

What do users say?

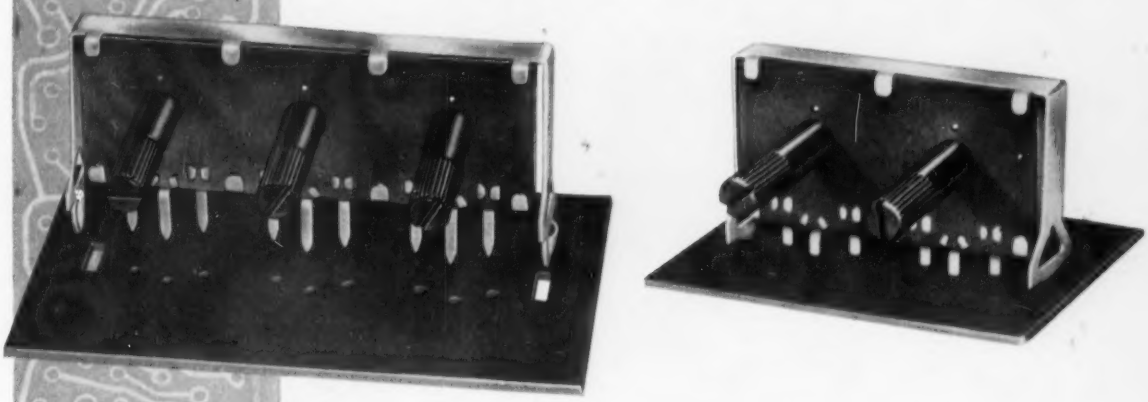
Major producers of electronic equipment report "Dutch Boy" solder with "Dutch Boy" *activated* flux gives them 50 to 60% more joints per pound. Piece workers swear by it. Costs move down.

But don't take *anybody's* word for it. Try it yourself. Send for free samples. Write National Lead Company, 111 Broadway, New York 6, N. Y.

"Dutch Boy" solders and fluxes

NOW!
designed specifically for PRINTED CIRCUITS

SNAPS INSTANTLY INTO PLACE—REMAINS FIRMLY LOCKED



Illustrations are actual size—note compact multiple units

CONSERVES PANEL SPACE—REDUCES HANDLING COSTS

A NEW TOTALLY FUNCTIONAL DESIGN CONCEPT

1. Snaps instantly into place with full length sturdy spring supports that lock control rigidly to printed panel.
   Wide shoulders provide rugged support.
   No mounting hardware, no separate support needed.
2. Compact multiple units conserve panel space, reduce handling costs and number of automatic assembly stations.
3. The only variable resistor with external contour designed specifically for mechanized handling and feeding into a printed panel.
4. Exclusive clip-off mounting supports and terminals for easy removal by service man without a solder pot.
5. Mounts upright with shafts parallel to printed panel, eliminating need for shaft protection during panel solder immersion.
6. Available in 2-control units (Series X52) or 3-control units (Series X53) as illustrated.

Many other types of controls available for your printed circuit and automation needs.

A CTS control can be tailored to your specific requirement. Let CTS SPECIALISTS help solve your current control problems. Write or phone today.

EAST COAST OFFICE
130 N. Broadway
Camden 2, New Jersey
Phone: Woodlawn 6-1668
TWX No. Camden NJ 380
Phila. Phone: Market 7-3129

WEST COAST OFFICE
928 S. Robertson Blvd.
Los Angeles 35, Calif.
Phone: Crestview 4-5931
TWX No. BEV H 7666

SOUTHWESTERN U.S.A.
John A. Green Company
6815 Oriole Drive
P.O. Box 7224
Dallas 9, Texas
Phone: Dixon 9918

CANADIAN DIVISION
C. C. Meredith & Co., Ltd.
Streetsville, Ontario
Phone: 310

SOUTH AMERICA
Jose Luis Pontet
Buenos Aires, Argentina
Montevideo, Uruguay
Rio de Janeiro, Brazil
Sao Paulo, Brazil

OTHER EXPORT
Sylvan Ginsbury
8 West 40th Street
New York 18, New York
Phone: Pennsylvania 6-8239

CTS

CHICAGO TELEPHONE SUPPLY
Corporation

ELKHART • INDIANA

The Exclusive Specialists in Precision Mass Production of Variable Resistors

Not just yet... but electronic products, for which Moloney presently manufactures magnetic components, are as advanced today as trips to the moon will be tomorrow.

And for these modern electronic applications, Moloney magnetic components prove superior in every respect... because Moloney's ability to design and fabricate efficient and dependable magnetic components is the result of more than 60 years experience in transformer manufacturing. Unsurpassed testing facilities certify the performance dependability of every Moloney magnetic component and assure complete satisfaction of industry requirements... or your own particular requirements. MC50-4

Get Dependability at its Best... Specify Moloney

Write for Catalog SR 206 "HyperCores for Magnetic Components" and Catalog ST 3506 "Magnetic Components for Electronics"

MOLONEY ELECTRIC COMPANY

HyperCores for Magnetic Components • Plate and Filament Transformers, Chokes, Unit Rectifiers Modulation Transformers and Reactors • Pulse Transformers and Charging Chokes • Power and Distribution Transformers

MOLONEY ELECTRIC — LIVE BETTER ELECTRICALLY

Sales Offices in All Principal Cities

Factories at St. Louis 20, Mo. and Toronto, Ont., Canada

LOOK TO G-E "THRU-CON" PRINTED CIRCUIT BOARDS FOR FAST, SURE RELIEF

General Electric "Thru-Con" Boards Eliminate Eyelets, Have Circuits Both Sides, Reduce Size and Weight

Aspirin can't help a product improvement headache—but a good design idea can! Printed circuitry, for example. A recent study shows that 7 out of 10 electronic and electric products may gain immediate improvements using printed circuits.

Circuits on Two Sides If Needed

Two-sided boards eliminate heavy metal parts, make miniaturization possible. Product is improved by simpler construction and more compact assembly design.

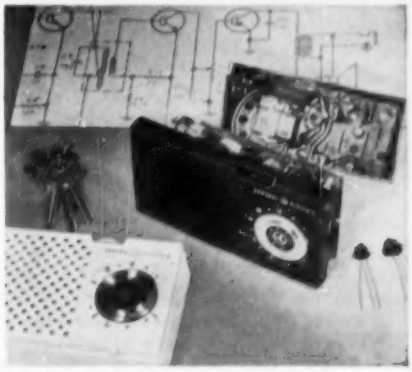
Printed Circuits Now In Many Products

G-E "Thru-Con" Boards are being used now in lamps, fans, street lighting systems, kitchen appliances, radios, television, and control equipment of many kinds. In addition, General Electric engineers are working with other industries in the development of design improvements with "Thru-Con" Boards.

G-E "Thru-Con" Man Has The Answers

Your G-E "Thru-Con" man can guide you along the road to better product design. He will analyze present designs, study assembly methods, discuss your market needs. Then, he will show you how "Thru-Con" Boards may help smooth the way for product improvements. Call him in, or, write: *General Electric Co., Electronic Components Dept., Section X446, Auburn, N. Y.*

G-E "Thru-Con" Printed Circuit Boards offer *positive connection through the holes,* without staking pins, patterns on both sides if needed. Printed circuitry cuts assembly time, eliminates product bulk and weight, reduces inspection time and parts inventory.

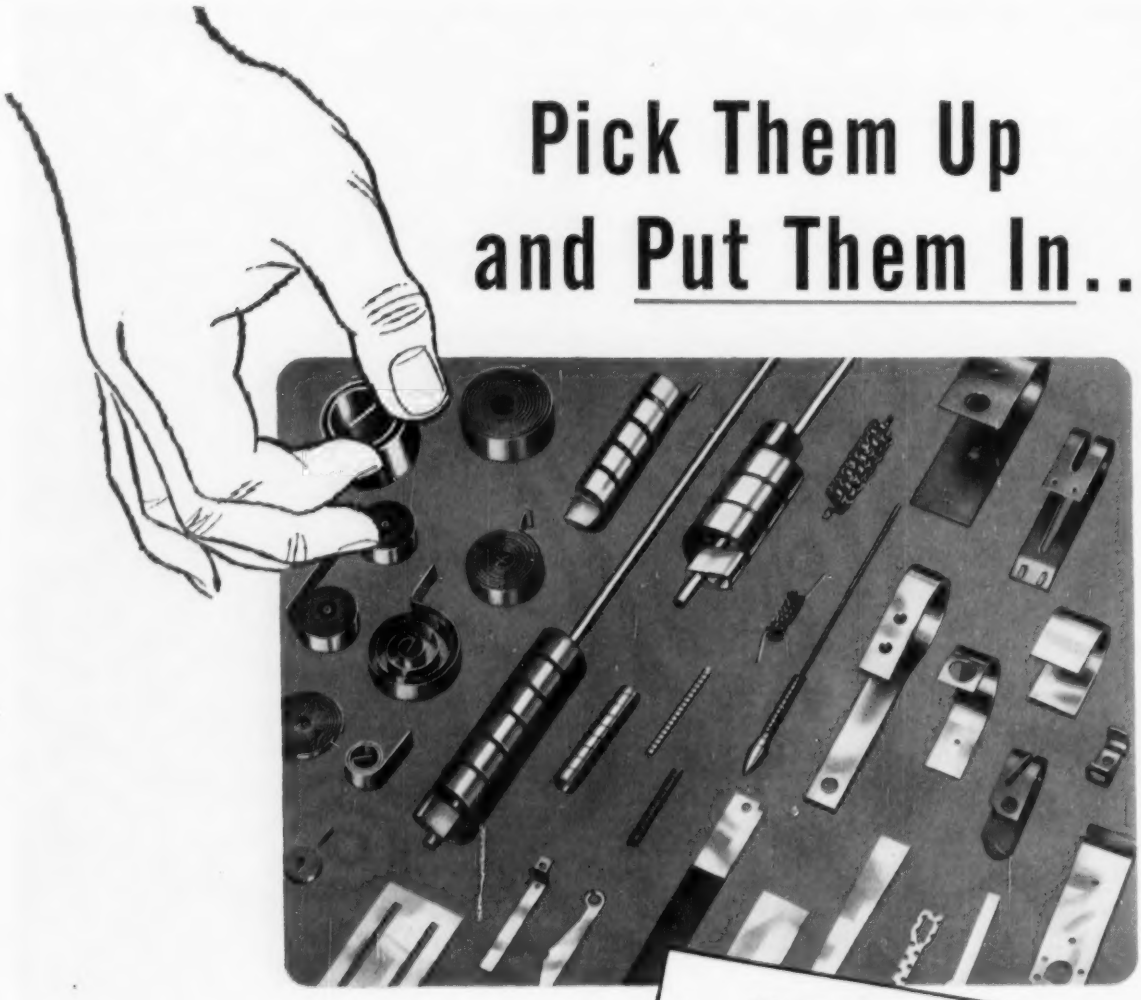


Positive Proof. This new transistorized portable radio features a full printed circuit using a General Electric "Thru-Con" Board. Combining other advances in electronics with a "Thru-Con" circuit makes possible sweeping changes in size, weight, and styling.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Pick Them Up and Put Them In...



Yes — it can be that simple when you use TRUFLEX Thermostat Metal elements and assemblies.

Give us the specifications you want to work to, and we'll make TRUFLEX Thermostat Metal parts that are really at home in your product.

Or, if you prefer to make your own thermal elements, General Plate will produce TRUFLEX in strip form to accurately meet your thermostat metal specifications. Either way you will find that General Plate TRUFLEX Thermostat Metal brings about worthwhile savings in production costs by reducing assembly problems in your products. You get consistently accurate performance of parts or strip because every order comes to you an exact duplicate of the original.

And remember — over forty different types of TRUFLEX Thermostat Metal are available to you — types covering a wide range of temperature extremes for thermostat applications — for immersion in water or steam without corrosion problems — in preferred resistance series to simplify calibrations of current operated devices — for needed spring characteristics in thermal latches — or what have you? Write for TRUFLEX Thermostat Metal Catalog and engineering assistance.

GENERAL PLATE

TRUFLEX®

THERMOSTAT METALS

Fit Into Your Product Picture

with economy, uniformity, and outstanding performance

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION

34 FOREST STREET, ATTLEBORO, MASSACHUSETTS

POLARAD

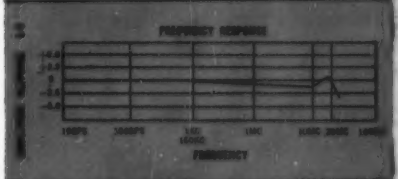
TV EQUIPMENT FOR STUDIO and LABORATORY

WIDE BAND VIDEO AMPLIFIER

10 cps to 20 mc

An oscilloscope deflection amplifier for measuring and analyzing pulses! Extremely wide band with extended low frequency response down to 10 cps. Will accurately analyze television signals. Excellent to increase the amplitude range of your vacuum tube voltmeters and signal generators.

MODEL VT



The Polarad Wide Band Video Amplifier offers an extremely wide band coverage: flat within ±1½ db from 10 cycles to 20 megacycles per second. It has a time delay of 0.02 microseconds and assures extreme stability because of its associated electronically regulated unit. A low capacity input probe is provided.

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

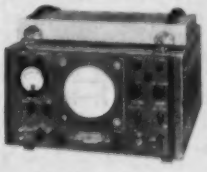
TV STUDIO MONITOR

MODEL M-105

MODEL M-105

The Polarad Model M-105 is portable — comes in sturdy aluminum case, can be rack mounted as well! And it is one of the finest instruments available to check the picture quality of video signals. Equipped with 12½" aluminized kinescope, capable of presenting highest definition transmitted pictures with exceptionally good "sync" stability over a wide range of operating conditions.

PORTABLE TV WAVE FORM MONITOR



MODEL TO-1

EXCELLENT FOR SUBCARRIER MEASUREMENTS

LOOK AT THESE FEATURES:

1. Can be rack mounted.
2. Can be used for both color and black and white TV.
3. Vertical Amplifier Bandwidth Switch for 2MC, 4MC, 6MC.
4. Special TV Sync. Circuits.
5. Horizontal Sweep Magnification 20 Tube Diameters.
6. Compact and Rugged.

VERTICAL MOUNT REGULATED POWER UNITS

Here are electronically regulated power units completely accessible from the front and back because of their vertical mount design. They have extremely fine regulation, low ripple content, and appreciable quantities of D.C. power.

MODEL PT-110

SPECIFICATIONS

	Model PT-110	Model PT-111
Output Voltage DC	400-450 Volts	250-300 Volts
Output Current	150-235 ma	100-400 ma
Output Impedance	Less than 1.5 ohms	Less than 1.5 ohms
Regulation	Better than 0.2%	Better than 0.2%
Ripple	Less than 12 mv rms	Less than 8 mv rms
Negative Supply	−150 V DC; 20 ma	−150V DC; 10 ma
Filament Supply	a. 6.3V ~ 12 a b. 6.3V ~ 12 a	a. 6.3V ~ 12 a AG b. 6.3V ~ 12 a
Power Input	105-125V 50/400 cps	105-125V 50/400 cps

MODEL PT-112

SPECIFICATIONS

	Model PT-111D Dual power unit, each side provides:	Model PT-112
Output Voltage	250-300 V DC	250-300 V DC
Output Current	100-400 ma	150-400 ma
Output Impedance	Less than 1.5 ohms	Less than 1.5 ohms
Regulation	Better than 0.2%	Better than 0.2%
Ripple	Less than 8 mv rms	Less than 8 mv rms
Line Voltage	105-125V, 50/400 cps	105-125V 50/400 cps
Series Operation Output Power	500-600 Volts 100-400 ma	
Parallel Operation Output Power	250-300 Volts 200-800 ma	

These features assure dependable, highest quality performance

- Precise electronic voltage regulation
- Low ripple content
- Does not utilize electrolytic condensers
- Sturdy construction
- Provisions for rack mounting

Polarad manufactures a complete line of color TV equipment including a Color Slide Scanner, Sync Generator, Bar Generator and Color Monitors.

POLARAD PROVEN RELIABILITY **ELECTRONICS CORPORATION** 43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

REPRESENTATIVES • Albuquerque • Atlanta • Baltimore • Boston • Buffalo • Chicago • Dayton • Englewood • Fort Worth • Los Angeles • New York Philadelphia • San Francisco • Syracuse • Washington, D. C. • Westbury • Winston-Salem • Canada, Arnprior, Toronto—Export: Rocke International Corporation

The Year Advertising Helped

IN 1954 we had a business recession in the United States. Sales fell about 4% during the year. If management had followed the historic pattern of business ups and downs, advertising volume would have fallen much further.

But in 1954 the volume of advertising did not fall. It increased over 5%. Every effort was made to stimulate sales when sales were needed to sustain prosperity.

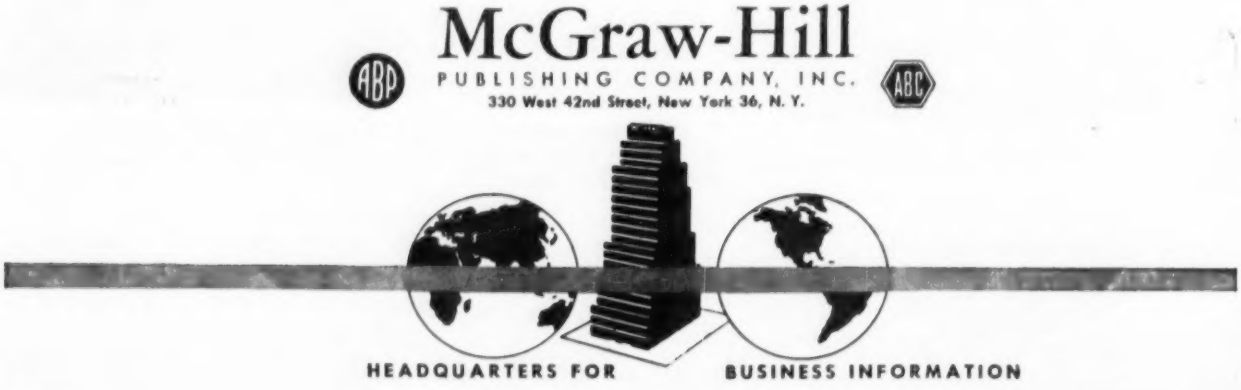
This was something entirely new under the sun. It had a powerful influence in making the recession of 1953-54 one of the mildest on record. It helped greatly to speed business on to the record-breaking levels it has attained today.

There are several reasons why America's business management attacked this decline in sales with more advertising. One of them grew out of the greatly strengthened position of the American consuming market. Consumers' income after taxes has been rising an average of over $10 billion a year since 1946, and this rising income is more widely distributed than ever before. Furthermore, consumers have piled up reserves of about $215 billion in cash or its equivalent. These reserves offer a new and powerful inducement to increased selling and advertising effort even in the face of a possible decline in consumer income.

Taking the Longer View

However, the principal reason why a sales decline was attacked with increased advertising is management's new-found conviction that good advertising is essentially an investment in the development of a market. Successful development requires sustained investment. The inclination of business management to take this longer view, is, of course, motivated by the fact that the American market, with over 3 million consumers being added annually, is growing at a prodigious rate.

Ten years ago only a handful of companies had plans for investment in new producing facilities extending beyond the current year. Today almost all leading companies have investment programs running some years ahead. And keeping pace with these long-range business investment plans has been the development of sales and advertising programs to



Kill a Business Recession

reach tomorrow's greatly expanded markets.

This crucial role of advertising in providing driving power for our economy is gaining greater recognition every day. In his recent book, "People of Plenty," Professor David M. Potter of Yale University remarked: "Advertising is not badly needed in an economy of scarcity, because total demand is usually equal to or in excess of total supply, and every producer can normally sell as much as he produces. It is when potential supply outstrips demand—that is, when abundance prevails—that advertising begins to fulfill a really essential economic function."

Advertising's Key Role

Today abundance so completely prevails in the United States that it has been conservatively estimated that as much as a third of everything offered for sale falls in the realm of "optional consumption." That is, consumers can "take it or leave it" without any immediate personal inconvenience. But if they decide to "leave it," a terrific economic depression will not be far behind. In such circumstances, advertising—in which, in all of its forms, we are now investing about $9.2 billion annually—clearly is of crucial importance to our continued prosperity.

In performing its key role in past years, American advertising never realized its full potential. It successfully promoted sales. But it never was called upon to promote an overall economic stability as a direct outgrowth of increased sales.

By successfully promoting both sales and economic stability, as it did in 1954, advertising surely has added new strength to the American economy. It has also added a great new and constructive dimension to advertising itself. This accomplishment gave great significance to the celebration of the first National Advertising Week in February, 1956.

One of the surest means of expanding your sales volume in today's $150 billion *industrial* market is through dominant advertising in the publications directly serving your major customers and prospects.

McGraw-Hill's business and technical publications can give you quick access to the men who initiate, specify and approve the purchases of industrial products and services. Because all are leaders in their respective fields, you are assured a maximum return on your investment when you specify a McGraw-Hill publication to carry your advertising to your most important markets.

You'll quickly find the right fuse for the job everytime—when you turn to BUSS Fuses

The complete BUSS fuse line includes: standard types, dual-element (slow blowing), renewable and one-time types — available in all standard sizes, and many special sizes and designs. Plus a companion line of fuse clips, blocks and holders.

Simplify your purchasing, stock handling and records — by standardizing on this one, reliable source for fuses.

BUSS Trademark is your assurance of "trouble-free" protection

BUSS fuses are electronically tested to make sure they will operate as intended under all service conditions. A sensitive device automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

Save engineering time on electrical protection problems. The BUSS fuse engineers are at your service to help you determine the fuse or fuse mounting best suited to your needs If possible, they will suggest a fuse or fuse mounting already available in local wholesalers' stocks, so that your device can be easily serviced.

For more information on BUSS and FUSETRON small dimension fuses and fuseholders, write for bulletin SFB.

ELRC 458

MAKERS OF A COMPLETE LINE OF FUSES FOR HOME, FARM, COMMERCIAL, ELECTRONIC, AUTOMOTIVE AND INDUSTRIAL USE.

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

BUSSMANN MFG. CO.
(Div. of McGraw Electric Co.)
UNIVERSITY AT JEFFERSON, ST. LOUIS 7, MO.

New from PHILCO...

SHOWN ACTUAL SIZE

ONLY 0.160" x 0.130"

World's Smallest Transistor

- **Hermetically sealed, resistance-welded metal case ... leads sealed in glass.**
- **Exceedingly low noise.**
- **Uniformity of electrical characteristics.**
- **Maximum reliability and long life.**
- **Impervious to moisture and humidity.**

Opens the way to new advances in space-saving audio design

A new achievement from Philco laboratories, the M-1 "Audio Mite" Transistor is smaller than any transistor now in production! It retains all the desirable electrical characteristics, all the mechanical features, all the performance of the Philco 2N47 . . . the transistor proved in the field to be without equal in hearing aid applications. The "Audio Mite" is hermetically sealed in metal the unique Philco way . . . the design that has earned a reputation as the most reliable hermetic seal in the industry. A wide new field in low level audio applications is opened to design engineers by this tiny PNP alloy junction transistor.

For complete technical information write to Dept. E-2

LANSDALE TUBE COMPANY
A DIVISION OF PHILCO CORPORATION
Lansdale, Penna.

PHILCO CORPORATION

LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA

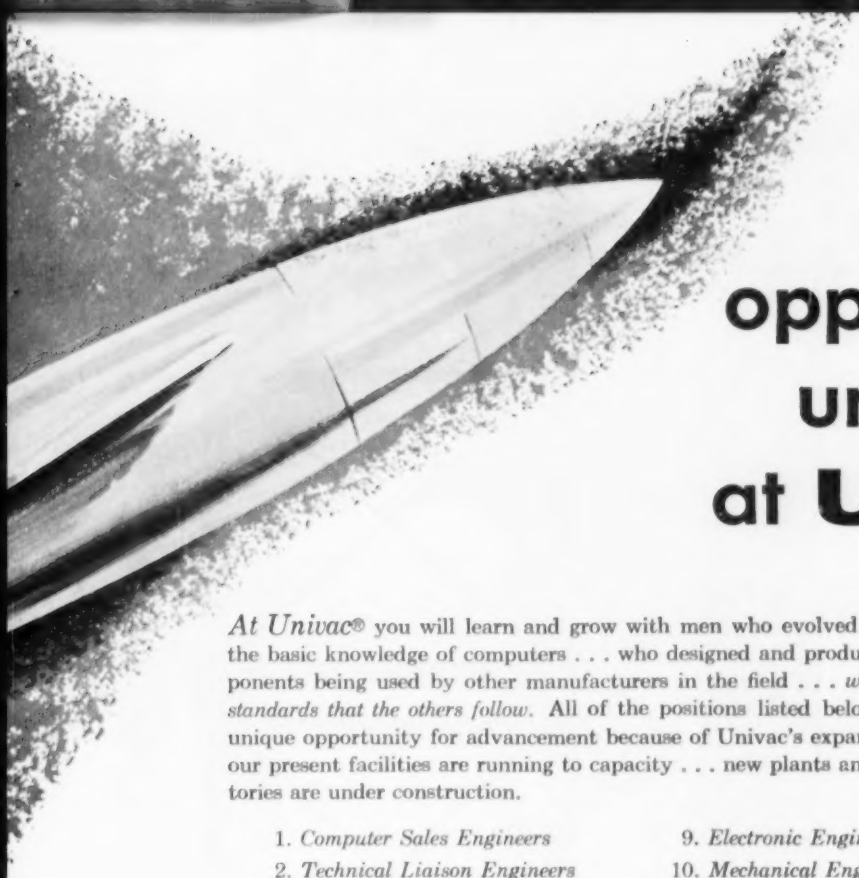
univac

proves itself at White Sands

On a hundred-mile strip of barren New Mexican soil, Uncle Sam has teamed up one of his newest and mightiest weapons of war—the guided missile—with one of science's latest marvels—the ingenious electronic computer built by Remington Rand Univac.

Closely associated to the guided missile testing program, the Remington Rand Univac Scientific has proved a real short cut in the development of this new weapon which may play a vital role in any future war. The task of this "electronic brain" is to compute and analyze the enormous amounts of data taken from each firing of a missile and turn out the results in time for its use when the next missile is fired. This enables the corps of experts conducting the tests to push forward the program much faster than otherwise would have been possible.

Each day at White Sands and numerous other places, the Remington Rand Univac Scientific proves itself "First in Electronic Computer Systems".



opportunities unlimited at UNIVAC

At Univac® you will learn and grow with men who evolved much of the basic knowledge of computers . . . who designed and produced components being used by other manufacturers in the field . . . *who set the standards that the others follow.* All of the positions listed below offer a unique opportunity for advancement because of Univac's expansion . . . our present facilities are running to capacity . . . new plants and laboratories are under construction.

1. *Computer Sales Engineers*
2. *Technical Liaison Engineers*
3. *Proposal and Quotation Experts*
4. *Metallurgists*
5. *Product Planning Engineers*
6. *Field Location Engineers*
7. *Contract Administration Engineers*
8. *Instrumentation and Component Sales Engineers*
9. *Electronic Engineers*
10. *Mechanical Engineers*
11. *Mathematicians*
12. *Physicists*
13. *Programmers*
14. *Logical Designers*
15. *Production Engineers*

A man doesn't advance very far or very fast from experience alone . . . that experience must be coupled with professional development and recognition by superiors . . . and a man who is only "holding his own", while others are advancing, is actually losing ground.

Professional advancement is dependent upon many factors such as association with recognized technical leaders . . . recognition of individual contribution through merit review, publication of technical papers and technical society membership . . . participation in management decisions and planning . . . the availability of a continuing formal educational program . . . the guidance of a young, technically trained management.

Now is the time to come to Remington Rand Univac where ambition and professional skill find their reward . . . advancement comes quickest in an expanding organization.

® Registered in U.S. Patent Office

FOR THE JUNE GRADUATE

FOR THE EXPERIENCED ENGINEER

FOR THE SCIENTIST

Send complete resume to

Remington Rand Univac

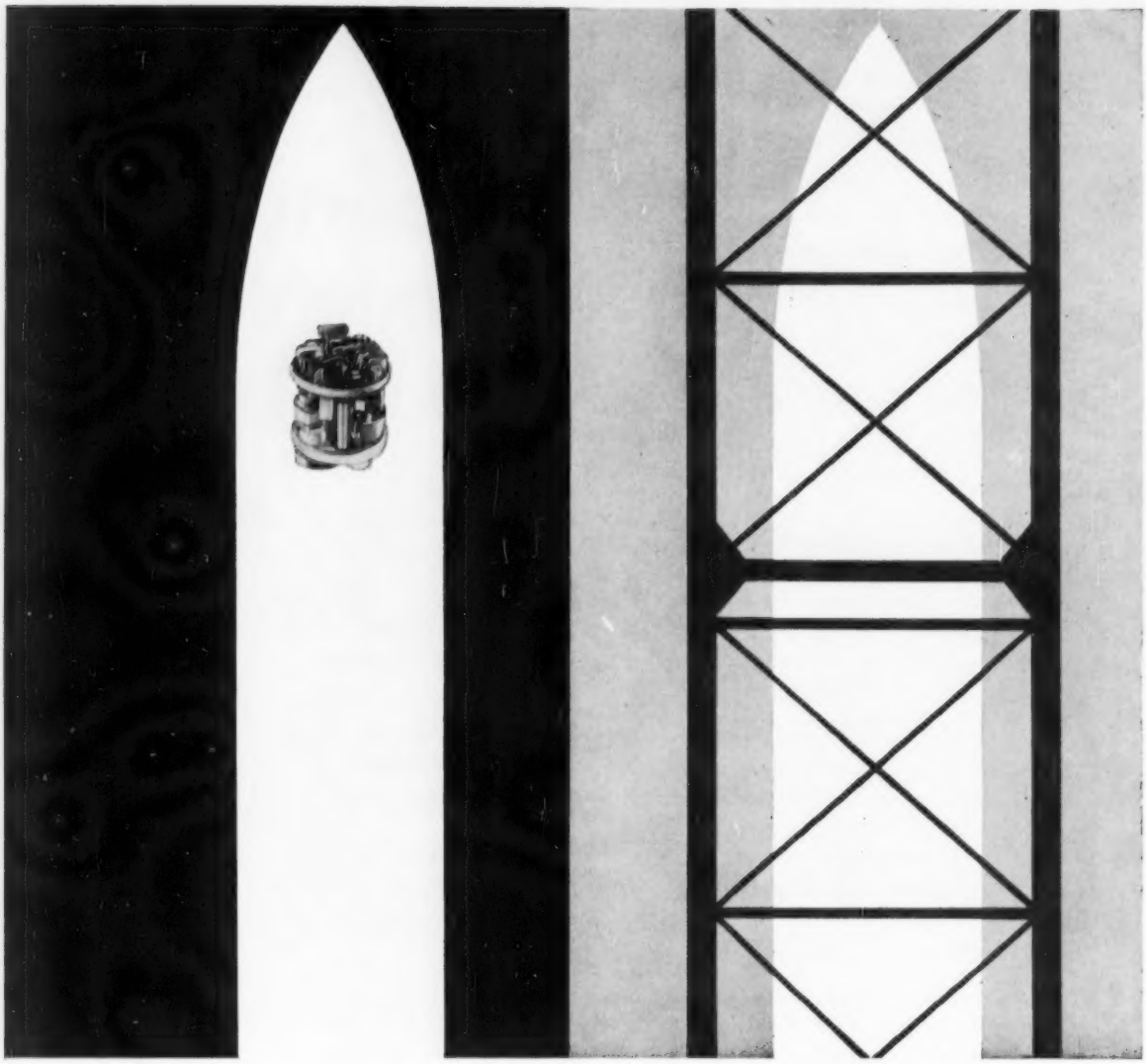
DIVISION OF SPERRY RAND CORPORATION

AT ANY OF THESE PLANT LOCATIONS

MR. D. A. BOWDOIN
Dept. AP-2
2300 W. Allegheny Ave.
Philadelphia, Pa.

MR. R. K. PATTERSON
Dept. AS-2
1902 W. Minnehaha Ave.
St. Paul W4, Minn.

MR. FRANK KING
Dept. AN-2
Wilson Avenue
South Norwalk, Conn.



From sensitive components to brawny launchers . . .

AMF has missile experience you can use

● "Precisioneering" power supplies for electronic control systems and developing complex launchers are two of AMF's *many* important contributions to our nation's missile programs ● Today, AMF plays a part in *more than half the missile programs now under way* ● And its activities cover practically every stage of design, development, and production . . . including mechanical, hydraulic, pneumatic and electronic test equipment . . . auxiliary power supplies . . . field and depot handling equipment . . . launchers . . . ground and flight control systems ● See for yourself why AMF's experience in missiles, as well as in a host of other fields, has made it the "can do" company.

Research, Development, Production in these fields:
- *Armament*
- *Ballistics*
- *Radar Antennae*
- *Guided Missile Support Equipment*
- *Auxiliary Power Supplies*
- *Control Systems*

Another AMF Product
DEFENSE PRODUCTS

Defense Products Group
AMERICAN MACHINE & FOUNDRY COMPANY
1101 North Royal Street, Alexandria, Va.

Want more information? Use post card on last page.

ANNOUNCING A NEW HIGH IN MAGNET PERMANENCY

Unique Ceramic Permanent Magnets are extremely resistant to demagnetization . . . Are virtually electrical non-conductors— Use no critical materials . . . Cost materially less

A LOW COST ceramic permanent magnet material developed by the Stackpole Carbon Company, St. Marys, Pa. combines adequate energy product with high coercive force, low residual induction, virtually 100% electrical resistivity and exceptional resistance to demagnetization. These unique characteristics plus the low cost and the non-critical nature of the ceramic make magnets of this material ideally fitted for all ordinary uses as well as highly critical applications such as those where the magnets may be exposed to strong demagnetizing fields.

No "Keepers" Needed

Known as Stackpole Ceramagnet* permanent magnets, the new units retain their energy even when used without "keepers" or other closed-circuit conditions, and in the presence of opposing fields.

As an example, Ceramagnet cannot be demagnetized by another magnet of a force up to 2,000 gauss.

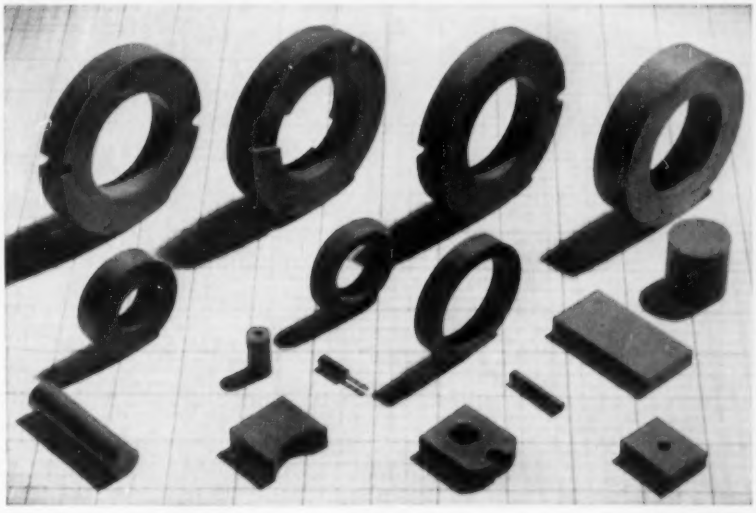
Ceramagnet magnets are practically non-conductors. Electrical resistivity is 6×10^{10} ohm-cm, making them ideally suited for high-frequency and high-voltage circuits. They can be placed in the direct path of electro-magnetic energy to rotate the polarization plane, to focus cathode ray tube beams or for similar purposes.

Unaffected by Strong Opposing Fields

Their magnetism is unaffected by their surroundings. They themselves exert little or no proximity effect on nearby circuitry.

Another feature that may offer interesting possibilities in some applications is the fact that Ceramagnet temperature characteristics are linear, including retrace, to 400°C.

Typical Ceramagnet applications range from magnetic focusing of cathode ray beam tubes to use on door latches, magnetic drives, instruments, oil filters, meters, toys, relays, magnetic attenuators, couplings, magnetic seals, motors, small generators, H-F alternators, magnetos, ion traps and others.



A TYPICAL GROUP of Stackpole Ceramagnet* ceramic permanent magnets. Practically any size or shape within the range of modern molding equipment can be supplied.

Cost Less, Weigh Less Than Metallic Magnets

Made of non-critical, inexpensive barium and iron oxides, the new Stackpole permanent magnets are blended, molded and sintered by much the same processes that have made Stackpole iron and ferromagnetic processes pre-eminent in the core fields for many years.

Ceramagnet is classed among the hard magnetic materials.

Cost is materially less than metallic magnets. Weight is also less . . . only 4.85 gms/cm³.

Although the energy product (0.915×10^6 gauss-oersteds) is less than that of metallic permanent magnets, the important point is that *Ceramagnet's full energy is available under practically any condition, even without "keepers".*

Even in cases where it might be necessary to use a larger Ceramagnet magnet, the cost factor would still be in its favor.

Units are machineable by wet grinding and may be machined *after* magnetizing.

Highest energy product is obtained by magnetizing across thinner sections although units can be magnetized in any direction.

Write for New Ceramagnet Data Bulletin

Complete engineering data on Ceramagnet including graphs of essential properties appears in the new Stackpole Ceramagnet Bulletin RC-10A. Copies are available on request to **Electronic Components Division, Stackpole Carbon Company, St, Marys, Pa.**

*Registered trademark

By specializing in servo motors only—not systems—G-M gives you these advantages...

- A broader line of servo motors in sizes and types to meet a wide range of applications.
- Servo motors available in *all* the standard sizes.
- Standard sizes specially modified to meet specific circuit requirements—available on a quick-service basis.
- Creative engineering in designing special motors with special characteristics.
- Faster production—better service.

When reliability under extreme conditions is essential—specify G-M Servo Motors! G-M has long specialized in supplying precision servo motors to the Military Avionic Industry, especially designed to meet military specifications for humidity, salt spray, temperature, vibration and altitude. Whatever your needs, let G-M build a servo motor with the *right* characteristics to perform to your specifications.

Write *today for G-M charts, specifications, or consultation.*

GM

G-M Servo Motors

manufactured by the Components Division of

G-M LABORATORIES INC.

4336 N. Knox Avenue • Chicago 41

Want more information? Use post card on last page.

now available for immediate delivery . . .

ADDITIONAL DIODES AVAILABLE

High Conductance Types **High Temperature Types**

High Resistance Types **JAN Types**

For high forward conductance . . . for high inverse resistance . . . for fast pulse recovery . . . for low impedance *and* fast forward switching time . . . whatever you require in a subminiature gold bonded glass diode, Clevite Transistor Products can deliver the diode you need in the quantity you want, *when you want it* . . . and at competitive prices!

Contact us for Prices and Specifications.

CLEVITE TYP

CLEVITE

TRANSISTOR PRODUCTS

241 Crescent St., Waltham 54, Mass. TWinbrook 4-9330

CHARACTERISTICS				
TYPE	Forward Current at +1V (ma. Min.)	Inverse Current at Specified V (μa. Max.)	Continuous Inverse Operating Voltage	DESCRIPTION
CTP-301	40	25 @ -50V 100 @ -20V @ 75°C	60	Inverse Recovery Time Tested.
CTP-320 (Equal to 1N67A)	5	50 @ -50V	80	Inverse Recovery Time Tested.
CTP-319	150	500K between -20 and -90V	90	Inverse Recovery Time Tested.
CTP-318	50	500K between -10V and -50V	60	Forward and Inverse Recovery Tested.
CTP-307	300	20 @ -30V	40	Inverse Recovery Tested.
1N270	200	100 @ -50V	60	Low Impedance Fast Forward Switching Time.
1N283	200	20 @ -10V	20	" "
1N273	100	20 @ -20V	30	" "
CTP-316	100	20 @ -50V 2 @ -10V	60	Hi Resistance Hi Conductance
1N198 JAN Type	4	50 @ -50V 10 @ -10V	80	Hi Temperature Diode

Want more information? Use post card on last page.

Standard Chrono-Tach shown front and center in "deep freeze" engine testing laboratory. (Courtesy of Thompson Products, Inc.)

LOOK TO THE INSTRUMENTS USED FOR DEPENDABLE END RESULTS

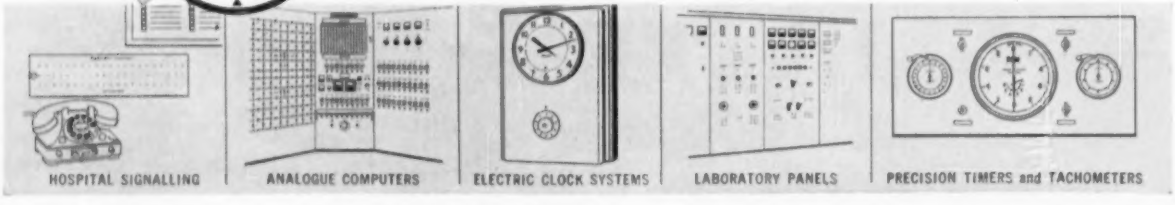
In almost every research and testing laboratory the information needed to obtain a specific end result depends upon knowing, to an accurate degree, the speed of revolving shafts, motors, governors or other rotating equipment.

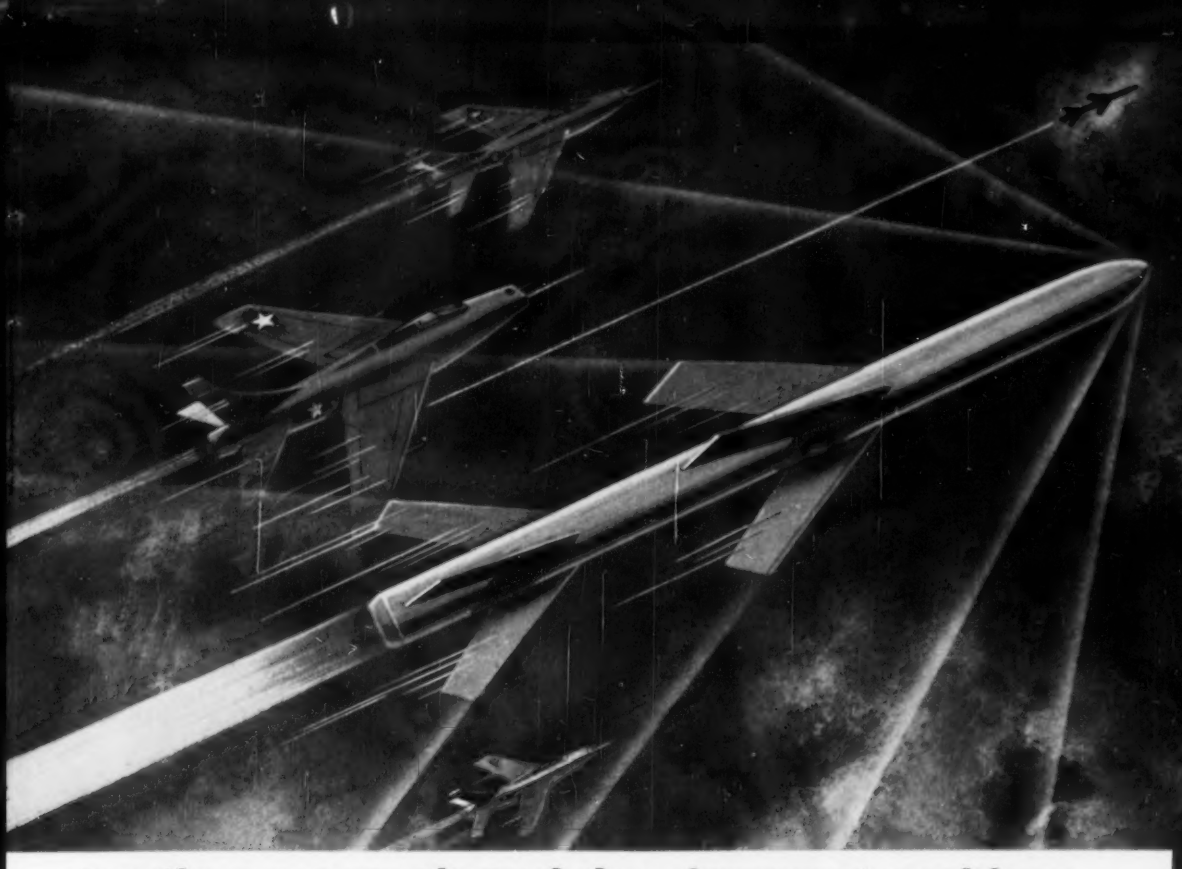
And it's a well-known fact that the end result can be no more reliable than the instruments that are used.

That's why the Standard Chrono-Tachometer plays such an important role in so many industrial, governmental and educational laboratories. Built for *continuous* service, it is a test instrument of extreme accuracy, invaluable wherever the precise measurement of speed of rotation is required.

Write for Engineering Bulletin #218

THE **Standard**
ELECTRIC TIME COMPANY
97 Logan Street • Springfield 2, Massachusetts





another research and development problem

Solved by Seeburg!

Navy selects Seeburg to develop telemetry . . .

PROBLEM—In the initial stages of a missile program, Seeburg was approached by the Bureau of Ordnance, Department of the Navy, to develop telemetering equipment . . . equipment which would transmit information while the missile was in flight.

SOLUTION—Now in production at Seeburg, and reliably performing the job for which it was intended, this Seeburg designed equipment is today checking and testing over 20 important channels of information.

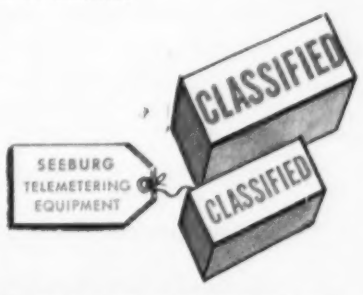
Solving highly complex electronic and electro-mechanical problems is a specialty with Seeburg, where a major portion of facilities and talents are permanently devoted to engineering and production of defense products. It's the reason why more and more procurement agencies and defense contractors are making it a practice to *see Seeburg first!*

ENGINEERS—You are invited to write us for complete information on challenging opportunities in our engineering division.

Servo Systems
Radar Assemblies
Aircraft Controls
Audio Amplifiers
Digital Storage Systems
Airborne and Shipboard
Navigation Equipment

Seeburg
CORPORATION
Established 1902
1500 North Dayton Street - Chicago 22, Illinois

High and Low Frequency R.F. Transmission and Receiving Sets
Guided Missile Electronic Units
Airborne Radar Antennas
Micro Wave Equipment
Magnetic Tape Recorders
Telemetric Equipment
Electronic Computers
Music Systems



WORLD'S LEADING MANUFACTURERS OF AUTOMATIC MUSIC SYSTEMS

THE

Heiland

119 AMPLIFIER SYSTEM FOR OSCILLOGRAPHIC RECORDING

COMPARE THESE FEATURES WITH SIMILAR SYSTEMS:

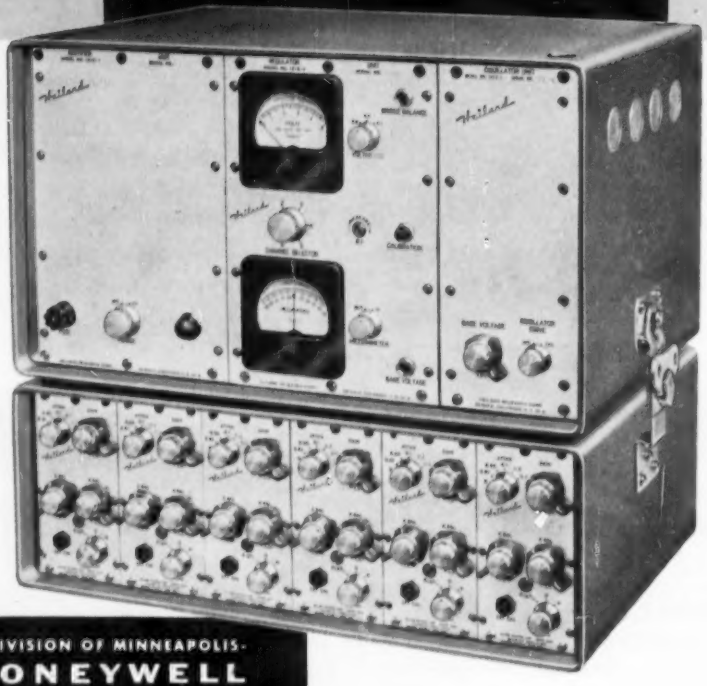
TWICE THE SENSITIVITY—½ millivolt for full current output

TWICE THE FREQUENCY RESPONSE—0 to 1000 c.p.s.

TEN TIMES THE CURRENT OUTPUT—50 ma into 20-ohm load

with—

EXCELLENT STABILITY—less than 2% variation with line voltage fluctuation and wide range of ambient temperatures



Carrier Amplifier Units for:

Resistive transducers

Linear differential transformer pickups

Variable reluctance gages

Linear-Integrating Amplifiers for:

Self-generating transducers.

Heiland® H HONEYWELL

A DIVISION OF MINNEAPOLIS-HONEYWELL

5200 E. Evans, Denver 22, Colo.

FOR ADDITIONAL DETAILS WRITE FOR BULLETIN 101K

All these features—plus many more—have moved Heiland 119 Amplifier Systems into leadership in the field!

All operating controls are on the front panel; all cabling is on the back panel for handy relay rack or test bench mounting without modification.

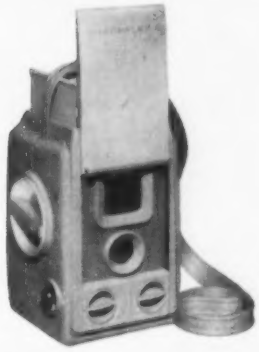
The 119 System is flexible to meet present or future needs, since all 6 individual amplifier units within the system are easily removable. You can build your system from the ground up, adding new individual units as your need expands.

In addition, linear-integrate and carrier units are interchangeable within the system case.

FOR PERFORMANCE AND CONVENIENCE—CHOOSE THE HEILAND 119 AMPLIFIER SYSTEM.

5 Waldes Truarc Rings simplify assembly, eliminate parts, bring big over-all savings to new design low-cost camera

Anscoflex II Camera

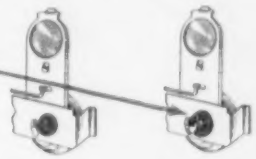


Key Shaft

Parts originally designed for self-locking Truarc ring (series 5105). Some cameras in the past had brass cup staked to the body. At times staking operation cracked the plastic, resulting in loss of expensive part.

Portrait and Filter Lens Knob Assemblies

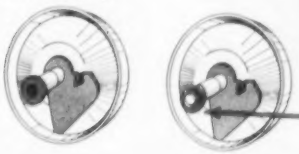
Old way: Knob with plastic shaft used washer and heat forming operation that flattened the plastic pin and locked the pivot in position.



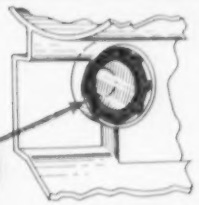
Truarc way: Molded plastic knob with pin is easily and quickly held by a Truarc self-locking ring (series 5105). No groove is necessary. Washer is eliminated and it is possible to remove ring if necessary without damage to knob.

Winding Knob

Old way: With screw and washer design, it was necessary to disassemble entire camera to remove screw which secured winding knob. Self-tapping screw sometimes failed to secure knob, produced excessive end play.



Truarc way: Truarc "E" ring (series 5133) allows removal of winding knob without major disassembly of camera, reducing repair time. Use of stacked rings and Truarc applicator saved $10.40 per M on labor. Material saving: $2.29 per M.

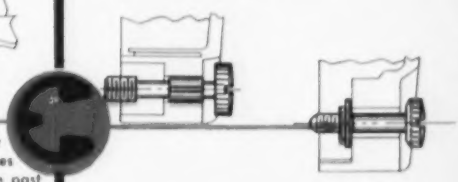


Rear Lens

Parts originally designed for self-locking Truarc ring (series 5005) Some cameras in the past had glass element secured by heat forming tabs from plastic body. Loose or chipped elements resulted in loss of both parts.

Flash-Gun Case Assembly

Old way: In the original design a sleeve was wrapped around neck of screw and pressed into hole of plastic cover. Close working areas made assembly difficult and required extra operation to lock ring into place.



Truarc way: Series 5133 E-Ring snaps onto unthreaded shank of screw quickly, needs no special groove. Labor saving $7.06/M.

Ansco, Binghamton, N. Y., uses the latest technical advances in construction to produce an economical, easy-to-use reflex camera. 5 Waldes Truarc Rings are used in this new design to save material and labor costs, eliminate parts, simplify assembly and reduce rejects.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

Send for new catalog supplement

WALDES

TRUARC®

RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name .....
Title .....
Company .....
Business Address .....
City ..... *Zone* ..... *State* .....

1048

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

ALLIED'S HERMETICALLY SEALED RELAYS

MECHANICAL SPECIFICATIONS										ELECTRICAL SPECIFICATIONS			
ALLIED TYPE	TYPE OF TERMINAL	OUTLINE DIMENSIONS AA	A	B	C	WT. (OZ.)	MOUNTING DIMENSIONS D	E	TYPE MOUNTING	CONTACT RATING (AMPS.)	CONTACT FORM MAX.	COIL DATA MAX. D.C. OHMS	OPERT.
ASM	SOLDER	2 7/16	2 1/16	1 7/8	1 7/16	3.5	.938	1.187	(3)#6-32 Studs	5	SPDT	3500 3485	AC DC
ASMO	PLUG-IN	3	2 7/16	1 7/8	1 7/16	4			Octal Plug-in	5	SPDT	3500 3485	AC DC
BJMR	SOLDER	3 1/32	2 1/32	1 15/64	1 1/32	7.5	.875	1.625	(3)#6-32 Studs	5	DPDT	3700 5000	AC DC
BJMRO	PLUG-IN	3 1/8	3 1/16	1 15/64	1 1/32	7.5			Octal Plug-in	5	DPDT	3700 5000	AC DC
BOM	SOLDER	3 1/32	2 1/32	2 1/16	DIA.	7.5	1.856	1.856	(4).206 Dia. Holes	10	DPDT	2675 5000	AC DC
BOMO	PLUG-IN	3 5/16	3	2 1/16	DIA.	8			Octal Plug-in	5	DPDT	2675 5000	AC DC
BOMR	SOLDER	3 1/16	2 1/16	1 15/64	1 1/64	8.5	1.250	1.250	(3)#8-32 Studs	10	DPDT	2675 5000	AC DC
BOMRO	PLUG-IN	3 1/32	2 1/32	1 15/64	1 1/64	8.5			Octal Plug-in	5	DPDT	2675 5000	AC DC
BOYM	SOLDER	3 1/32	2 1/32	2 1/16	DIA.	8.5	1.856	1.856	(4).206 Dia. Holes	10	DPDT	10,000	DC
BOYMO	PLUG-IN	3 5/16	3"	2 1/16	DIA.	8.5			Octal Plug-in	5	DPDT	10,000	DC
BOYMR	SOLDER	3 1/16	2 1/16	1 15/64	1 1/64	8.5	1.250	1.250	(3)#8-32 Studs	10	DPDT	10,000	DC
BOYMRO	PLUG-IN	3 1/32	2 1/32	1 15/64	1 1/64	8.5			Octal Plug-in	5	DPDT	10,000	DC
CNAH	SCREW	4 1/2	3 5/16	2 1/32	2 1/32	22	1 1/8	2"	(3)#10-32 Studs	50	SPST	600 4460	AC DC
DSM	SOLDER	3 1/32	3 1/32	3 1/2	1 7/8	13	1.375	3.125	(4).206 Dia. Holes	5	DPDT	8,000	DC
DSMR	SOLDER	3 5/8	3 1/4	2 1/4	1 13/32	9.5	.687	1.750	(3)#8-32 Studs	5	DPDT	8,000	DC
KM-3-1D	PLUG-IN	1 1/64	5/64	2 3/64	45/64	0.33			7 Pin Plug-in	1/2	SPDT SPST NO	1,500	DC
KM-3-2D	PLUG-IN	1 1/64	5/64	2/64	45/64	0.33			7 Pin Plug-in	1/2	SPDT SPST NC	1,500	DC
KH-6D	PLUG-IN	1 1/64	5/64	.396	.800	0.33			8 Pin Plug-in	1/2	DPDT	5,000	DC
LKH-6C	SOLDER	3 5/16	3 1/16	1 7/8	1 7/8	8.5	1.375	1.500	(3)#6-32 Studs	2	6PDT	11,000	DC
LKH-4C	SOLDER	3 1/16	2 11/16	1 7/8	1 7/16	6	.938	1.187	(3)#6-32 Studs	2	4PDT	11,000	DC
LKHO	PLUG-IN	3 5/16	3"	1 7/8	1 7/16	5.5			Octal Plug-in	2	DPDT	11,000	DC
MEH-6	SOLDER	2 1/32	1 21/32	1 7/8	1"	3	.672	1.047	(3)#6-32 Studs	5	DPDT	1330 2930	AC DC
MEHG	PLUG-IN	2 7/32	1 27/32	1 7/8	1"	3.5	.750	1.125	Note 1 (3)#6-32 Studs	5	DPDT	1330 2930	AC DC
MEHX	SOLDER	2 5/8	2 1/16	1 5/8	1 7/16	5.3	.938	1.187	Note 2 (3)#6-32 Studs	5	4PDT	7260	AC DC
MH-6D	SOLDER	1 13/64	1 13/64	1 1/64	DIA.	1	CTR CTR	.875	(2) Holes 125 Dia.	2	DPDT	15,900	DC
MH-12	SOLDER	1 21/32	1 13/64	1 1/64	DIA.	2.5	CTR CTR	1.406	Note 3 (2)#6-32 Studs	2	4PDT	16,000	DC
MH-18	SOLDER	1 21/32	1 13/64	1 1/16	DIA.	4	CTR CTR	1.562	Note 3 (2)#6-32 Studs	2	6PDT	22,100	DC
MHT-12	SOLDER	2 1/8	1 13/16	1 1/64	DIA.	3	CTR CTR	.625	Note 3 (2)#6-32 Studs	2	4PDT	16,000	DC
MHT-18	SOLDER	2 1/8	1 13/16	1 1/16	DIA.	4.5	CTR CTR	.625	Note 3 (2)#6-32 Studs	2	6PDT	22,100	DC
MHK-12	SOLDER	1 5/8	1 1/2	1 1/64	DIA.	3.5	.938	1.187	(3)#6-32 Studs	2	4PDT	16,000	DC
MHUO-12	PLUG-IN	1 5/8	1 13/64	1 1/64	DIA.	2.5	CTR CTR	1.406	Note 4 (2)#6-32 Thd.	2	4PDT	16,000	DC
MHLO-12	PLUG-IN	1 5/8	1 13/64	1 1/64	DIA.	2.5	CTR CTR	1.531	Note 4 (2)#10-32 Thd.	2	4PDT	16,000	DC
MHUO-18	PLUG-IN	1 5/8	1 13/64	1 1/16	DIA.	4.0	CTR CTR	1.562	Note 4 (2)#6-32 Thd.	2	6PDT	22,100	DC
MHLO-18	PLUG-IN	1 5/8	1 13/64	1 1/16	DIA.	4.0	CTR CTR	1.687	Note 4 (2)#10-32 Thd.	2	6PDT	22,100	DC
*MHJ-12	SOLDER	1 21/32	1 13/64	1 1/64	DIA.		CTR CTR	1.406	(2)#6-32 Studs	2	4PDT	16,000	DC
*MHJ-18	SOLDER	1 21/32	1 13/64	1 1/16	DIA.		CTR CTR	1.562	(2)#6-32 Studs	2	6PDT	22,100	DC
MHY-6	SOLDER	1 13/16	1 13/64	1 1/64	DIA.		CTR CTR	1.406	(2)#6-32 Studs	10	DPDT	16,000	DC
MHY-12	SOLDER	1 49/64	1 13/64	1 1/16	DIA.		CTR CTR	1.562	(2)#6-32 Studs	10	4PDT	22,100	DC
PBMW-6	SOLDER	2 5/8	2 1/4	1 45/64	1 1/64	6	CTR CTR	1.468	Note 3 (2)#6-32 Studs	10	DPDT	380 4800	AC DC
PBM-6	SOLDER	2 5/8	2 1/4	1 45/64	1 1/64	6	1.218	1.218	(4)#6-32 Studs	10	DPDT	380 4800	AC DC
PBM-9	SOLDER	2 27/32	2 1/4	1 45/64	1 1/64	6	1.218	1.218	(4)#6-32 Studs	10	3PDT	380 4800	AC DC
PBM-12	SOLDER	2 27/32	2 1/4	1 45/64	1 1/64	6.5	1.218	1.218	(4)#6-32 Studs	10	4PDT	380 4800	AC DC
PBMN-6	PLUG-IN	3 1/32	2 1/32	1 45/64	1 1/64	9	Note 3		"AN" CONNECTOR	10	DPDT	380 4800	AC DC
PBMN-9	PLUG-IN	3 1/32	2 1/32	1 45/64	1 1/64	9	Note 3		"AN" CONNECTOR	10	3PDT	380 4800	AC DC
PBMN-12	PLUG-IN	3 1/32	2 1/8	1 45/64	1 1/64	9.5	Note 3		"AN" CONNECTOR	10	4PDT	380 4800	AC DC
PDM-6	SOLDER	2 11/16	2 1/16	1 1/8	1 7/16	6	.938	1.187	(3)#6-32 Studs	2	DPDT	475 4800	AC DC
PDM-9	SOLDER	2 11/16	2 1/16	1 1/8	1 7/16	6	.938	1.187	(3)#6-32 Studs	2	3PDT	475 4800	AC DC
PDM-12	SOLDER	2 11/16	2 1/16	1 1/8	1 7/16	6.5	.938	1.187	(3)#6-32 Studs	2	4PDT	475 4800	AC DC
PDMG	PLUG-IN	2 5/16	2 1/16	1 1/8	1 7/16	6.5	Note 1		14 Pin Plug (3)#6-32 Studs	2	4PDT	475 4800	AC DC
POMR-9	SOLDER	3 5/32	3 1/32	1 7/8	1 7/8	12	1.375	1.437	(3)#8-32 Studs	10	3PDT	870 5000	AC DC
POMR-12	SOLDER	3 5/32	3 1/32	2 1/4	2 1/8	13.5	1.625	1.812	(3)#8-32 Studs	10	4PDT	870 5000	AC DC
POMRO-12	PLUG-IN	4 1/16	3 1/32	2 1/4	2 1/8	13.5			14 Pin Plug-in	5	4PDT	870 5000	AC DC
PRH	SOLDER	3 1/32	2 27/32	3 1/8	1 13/32	9.5	CTR CTR	2.687	(2) .161 Dia. holes	10	4PDT	620	DC
RSH-3D	SOLDER	2 1/64	1 49/64	¾ DIA.		2.0	CTR CTR	.973	(2).125 dia. clearance holes	2	3PDT	14,000	DC
RSH-6D	SOLDER	2 1/64	1 49/64	¾ DIA.		2.0	CTR CTR	.973	(2).125 dia. clearance holes	2	DPDT	14,000	DC
RSHO-6D	8 PIN PLUG-IN	2 1/64	1 49/64	¾ DIA.		2.0	CTR CTR	.973	8 pin plug-in ‡ keyway † (2).125 dia. clearance holes	2	DPDT	14,000	DC
RSH-3D	7 PIN PLUG-IN	2 1/8	1 13/64	¾ DIA.		2.0			7 Pin Plug-in	2	3PDT	14,000	DC
SKH	SOLDER	2 5/8	2 1/16	1 1/8	1 7/16	4.5	.938	1.187	(3)#6-32 Studs	2	4PDT	4,500	DC
SKHO	PLUG-IN	3	2 1/16	1 1/8	1 7/16	5			Octal Plug-in	2	DPDT	4,500	DC
SKHW	SOLDER	2 5/8	2 1/16	1 1/8	1 7/16	4.5	.938	1.187	Note 3 (3)#6-32 Studs	3	4PDT	4,500	DC
SKHG	PLUG-IN	2 5/8	2 5/32	1 1/8	1 7/16	5	Note 1		14 Pin Plug-in(3)#6-32 Studs	2	4PDT	4,500	DC
SKHH	PLUG-IN	3 5/32	2	1 1/8	1 7/16	6.8	Note 3		"AN" CONNECTOR	2	4PDT	4,500	DC
SWHO	PLUG-IN	2 11/16	2 1/8	1 1/8	1 7/16	5.5			Octal Plug-in	2	DPDT	13,800	DC
SWH	SOLDER	2 5/8	2 1/16	1 1/8	1 7/16	5.5	.938	1.187	(3)#6-32 Studs	2	DPDT	13,800	DC
7BH	SOLDER	5 15/16	3	5	4 11/32	17	4	3.812	(6) .157 Holes	.2 Amp. at 16000V.	SPDT	110 2630	AC DC

* NOTE: MHJ type relays are available in all MH type mountings.

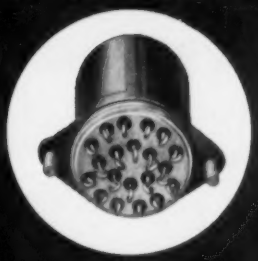
NOTE 1: Use 14 pin miniature socket

NOTE 2: Two Relays in one enclosure

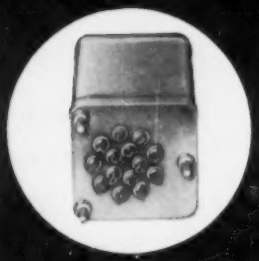
NOTE 3: Air Force approved

NOTE 4: Sockets available from Allied Control

TYPES OF MOUNTINGS AND TERMINALS

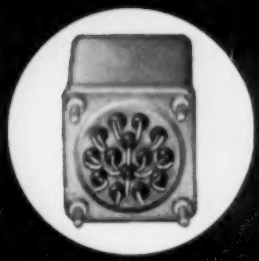


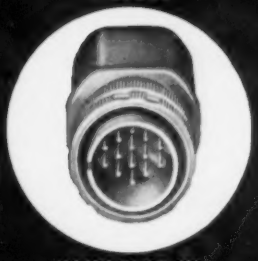
2 STUDS



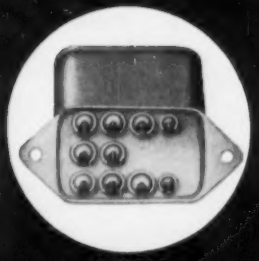
3 STUDS

4 STUDS

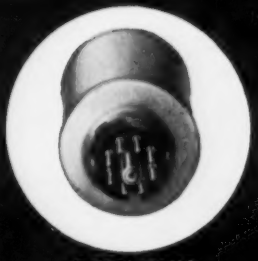




"AN" PLUG-IN



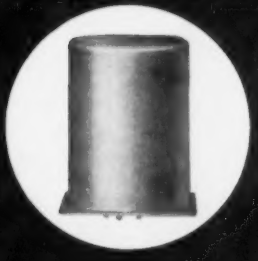
2 HOLE

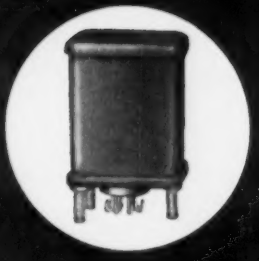


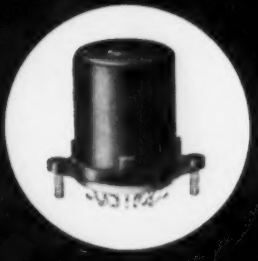
OCTAL PLUG

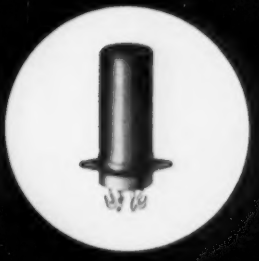
14 PIN PLUG-IN

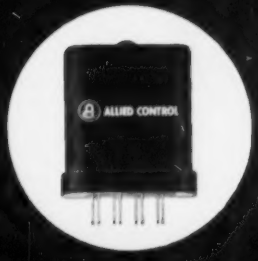
TYPES OF HOUSINGS

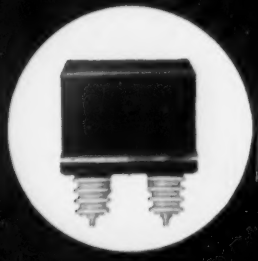


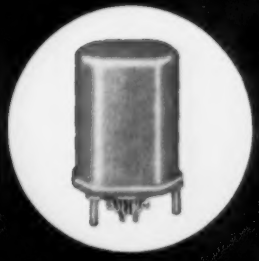












OUTLINE DIMENSIONS:

OCTAGON

RECTANGLE OR SQUARE

ROUND

SIDE VIEW

TYPE TERMINALS:

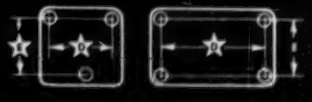
SOLDER TERMINAL

OCTAL 8 PIN PLUG

"AN" CONNECTOR

14 PIN PLUG-IN

MOUNTING DIMENSIONS:



ALLIED CONTROL

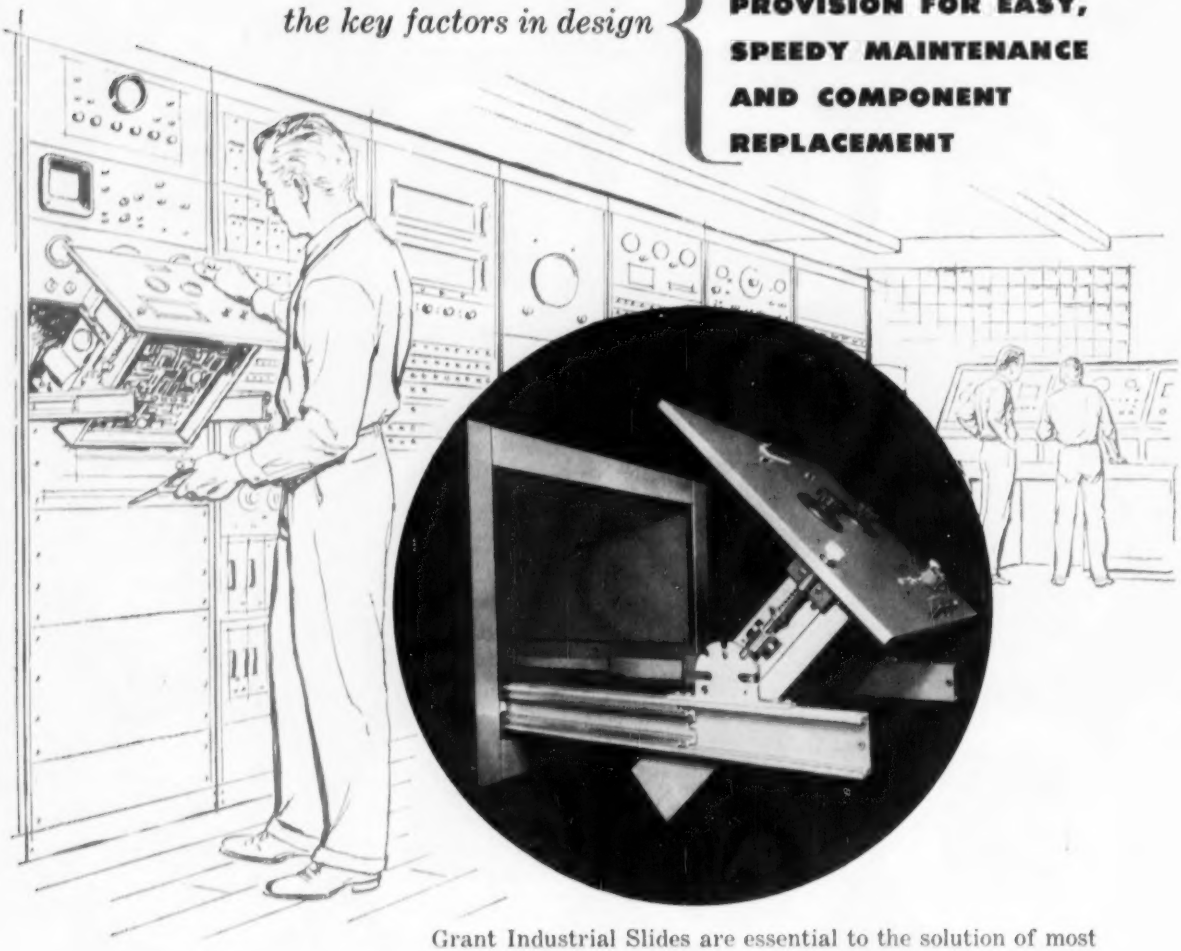
ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N.Y.

AL168

Grant INDUSTRIAL SLIDES FOR

the key factors in design

ACCESSIBILITY
COMPACTNESS
PROVISION FOR EASY, SPEEDY MAINTENANCE AND COMPONENT REPLACEMENT



Grant Industrial Slides are essential to the solution of most problems centering on these design factors—so highly emphasized in this automation era. Grant Slides provide skillfully developed, competently engineered sliding, pivoting mountings for nearly all types of assemblies—electronic, hydraulic, pneumatic, mechanical.

Grant engineers and representatives are located in all important industrial centers—their valuable store of specialized experience is yours for the asking.

More Than 100 Pages of Important Working Data

The Grant Industrial Slide Catalogue—on the press—outlines principles, details, of more than 100 standard and custom-made slides. A working manual on built-in accessibility. Ask us to reserve your free copy.

Grant INDUSTRIAL SLIDES

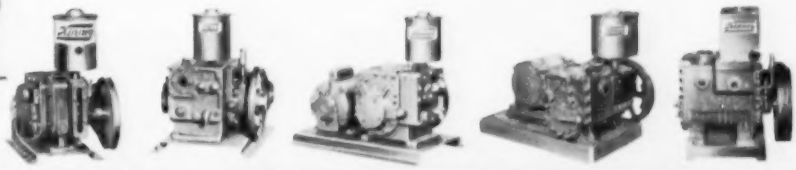
Grant Pulley and Hardware Corporation
31-85 Whitestone Parkway, Flushing 54, N. Y.
944 Long Beach Avenue, Los Angeles 21, California

Want more information? Use post card on last page.

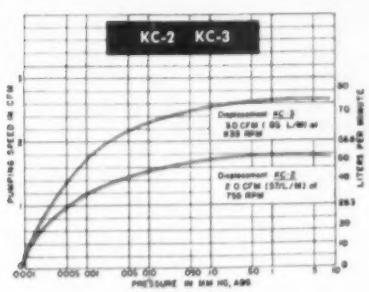
SPOTLIGHTS ON THE SCIENTISTS number 4 of a series

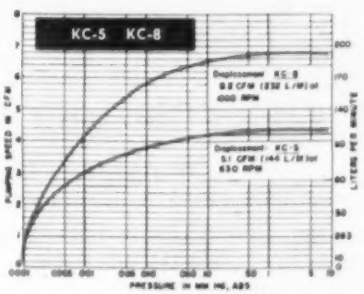
The facts speak for themselves! We rest our case!!

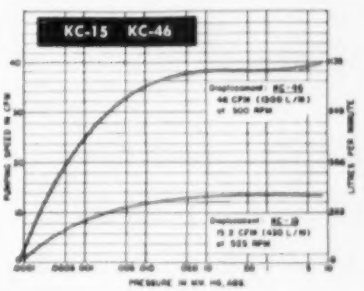
KINNEY COMPOUND HIGH VACUUM PUMPS



SPECIFICATIONS	MODEL KC-2	MODEL KC-3	MODEL KC-5	MODEL KC-8	MODEL KC-15	MODEL KC-46
Free Air Displacement	2.0 CFM	3.0 CFM	5.1 CFM	8.2 CFM	15.2 CFM	46.0 CFM
Free Air Displacement	56.5 Liters/min.	85.0 Liters/min.	144. Liters/min.	232. Liters/min.	430 Liters/min.	1300 Liters/min.
Free Air Displacement	.95 Liters/sec.	1.41 Liters/sec.	2.4 Liters/sec.	3.9 Liters/sec.	7.2 Liters/sec.	21.7 Liters/sec.
RPM	755	1135	630	1000	525	500
Motor H.P.	¼	⅓	⅓	½	1	3
Motor RPM (syn.)	1800	1800	1800	1800	1800	1800
Oil Capacity	6 oz.	6 oz.	1⅓ pt.	1⅓ pt.	2 qt.	1 gal.
Shaft Diam.	¾"	¾"	¾"	¾"	¾"	1⅛"
Inlet Connection	¾" Screwed	¾" Screwed	1" Screwed	1" Screwed	2" Screwed	3" Screwed
Outlet Connection	None	¾" Screwed	1" Screwed	1" Screwed	1¼" Screwed	1½" Screwed
Net Weight, Complete	70 lb.	78 lb.	140 lb.	148 lb.	300 lb.	585 lb.







SUMMATION

- Reliable High Vacuum (Cam and piston displacement)
- Rapid Recovery of Vacuum
- Simple to Maintain
- Dynamically Balanced
- Standard Small Motors
- Gas Ballasted (optional)
- Economical
- Dependable
- Small, Compact Design

VERDICT

Your verdict will be FAVORABLE when you review all the facts. Request Bulletin 403 for additional data or contact one of our competently staffed district offices in Baltimore, Chicago (LaGrange), Cleveland, Los Angeles, New York, Philadelphia, San Francisco, or St. Louis.

write today

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
3565 WASHINGTON STREET • BOSTON 30 • MASS.
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N.Y.

- PLEASE SEND BULLETIN 403 giving complete data on Kinney Compound Pumps
Our vacuum problem involves .....

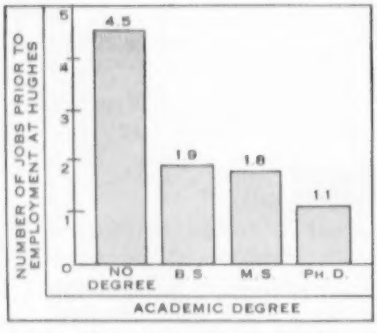
Name .....
Company .....
Street .....
City ..... State .....

Want more information? Use post card on last page.

HUGHES

Some of the young fellows on our staff have been analyzing our files of personal data regarding scientists and engineers here at Hughes. What group characteristics would be found?

With additional facts cheerfully contributed by their colleagues they have come up with a score of relationships—some amusing, some quite surprising. We shall chart the most interesting results for you in this series.



The above chart represents the number of positions held prior to employment at Hughes—by academic degrees (and by lack of a degree). The Ph. D. has changed jobs the least. Data obtained from a 20% random sample of the 2400 professional engineers and scientists of Hughes Research and Development Laboratories.

Education and Job Change

In our laboratories here at Hughes, more than half of the engineers and scientists have had one or more years of graduate work, one in four has his Master's, one in 15 his Doctor's. The Hughes research program is of wide variety and scope, affording exceptional freedom as well as exceptional facilities for these people. Indeed, it would be hard to find a more exciting and rewarding human climate for a career in science. Too, the professional level is being stepped up continually to insure our future success in commercial as well as military work.

Hughes is pre-eminent as a developer and manufacturer of airborne electronic systems. Our program includes military projects in ground and airborne electronics, guided missiles, automatic control, synthetic intelligence. Projects of broader commercial and scientific interest include research in semiconductors, electron tubes, digital and analog computation, data handling, navigation, and production automation.

Scientific Staff Relations **Hughes**

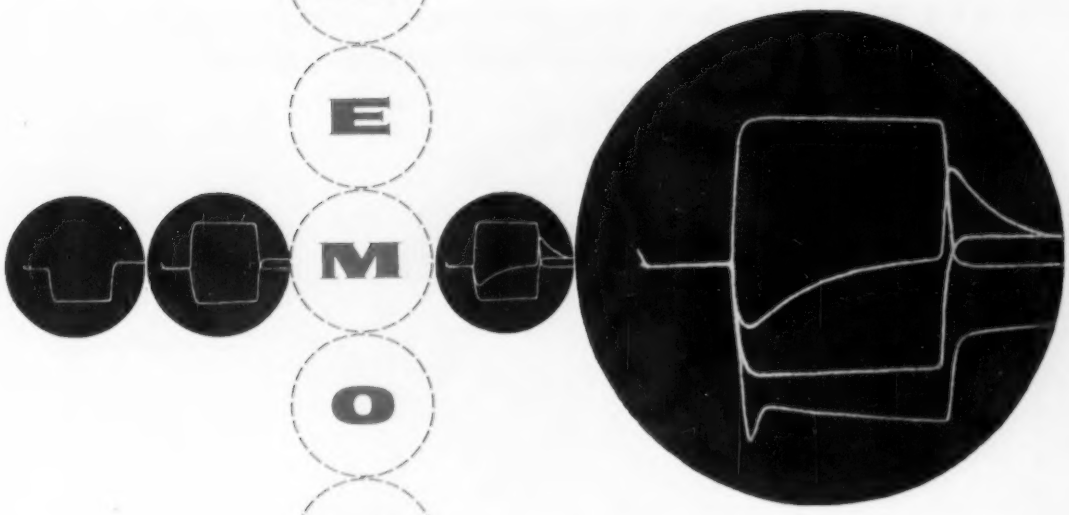
RESEARCH
AND DEVELOPMENT
LABORATORIES

Culver City, Los Angeles County, California

RIGHT NOW *the Laboratories have positions open for engineers with experience in the design of electronic circuits in all areas mentioned in this advertisement.*

a VOM ...plus a VTVM when you need it.

HUGHES MEMOTRON



Successive traces of waveforms associated with one-shot multivibrator, visually stored by MEMOTRON.

SAVE VALUABLE TIME, WASTED FILM

Transients need not be photographed unless a file record is needed. When such a record is required, photography is greatly simplified, because all displays occur at a constant, uniform brightness regardless of difference in writing speeds. Therefore, a single camera exposure setting is sufficient.

FOR PERMANENT TRANSIENTS

Now non-recurrent phenomena ("transients") can be held and studied directly on the viewing screen of your oscilloscope. The HUGHES MEMOTRON—first in a new series of direct-display cathode ray storage tubes—captures and retains waveforms visibly until they are intentionally erased.

Since the MEMOTRON will display and retain successive writings, it is ideal for plotting curves. The tube will also store reference lines for convenient data analysis.

Our engineering staff invites your inquiries concerning specific laboratory and industrial applications for these tubes.

MEMOTRON
GENERAL SPECIFICATIONS

RESOLUTION...60 written lines per inch.
WRITING SPEED...From zero to at least 50,000 inches/sec.
BRIGHTNESS...50 foot-lamberts.
USABLE SCREEN DIAMETER...4 inches, minimum.
DIMENSIONS...Over-all length: 18 3/4 inches, ± 1/2-inch.
Bulb diameter: 5 5/8 inches, maximum.
Neck diameter: 2 1/4 inches, ± 3/32-inch.

HUGHES PRODUCTS

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

For descriptive literature, please write:

ELECTRON TUBES
HUGHES PRODUCTS
International Airport Station
Los Angeles 45, California

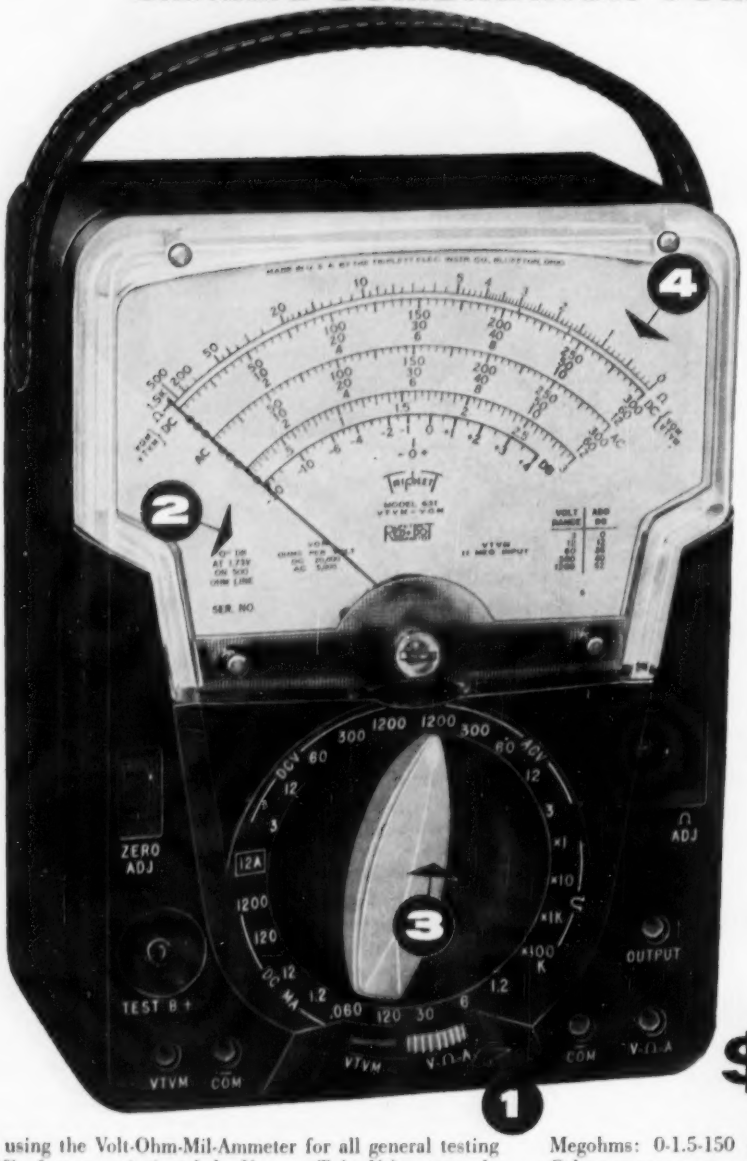
© 1956, H.A.C.

Double check the Core Manufacturer with the low price and quick delivery promises, which do not permit intelligent engineering and careful production.

a VOM ...plus a VTVM when you need it.

DOUBLE USE...HALF THE PRICE

TRIPLETT MODEL 631—In one year accepted as the standard COMBINATION VOM-VTVM



Battery operated

1 Just flip the switch.

2 Standard sensitivities as used in servicing manuals.

3 34 ranges—with the famous Triplett single knob control.

4 Extra long scales —unobstructed visibility.

$59.50

By using the Volt-Ohm-Mil-Ammeter for all general testing (90% of your testing) and the Vacuum Tube Voltmeter only when you need it, you have the advantage of a VTVM with extremely long battery life. Batteries are used only about one-tenth as much as in the ordinary battery-operated VTVM. Features: Ohms, 0-1500-15,000 (6.8-68 center scale. First division is 0.1 ohm.)

Megohms: 0-1.5-150 (6,800-680,000 ohms center scale.) Galvanometer center mark "—0+" for discriminator alignment.

RF Probe permits measurements up to 250 MC. $7.00 net extra.

Featured by leading electronic parts distributors everywhere.

TRIPLETT

TRIPLETT ELECTRICAL INSTRUMENT COMPANY • 52 years of experience • BLUFFTON, OHIO

Triplett design and development facilities are available for your special requirements for meters and test equipment.

Moloney power transformers are dried in new controlled atmosphere oven

Double check the Core Manufacturer with the low price and quick delivery promises, which do not permit intelligent engineering and careful production.

Only the Big

NATIONAL MOLDITE COMPANY

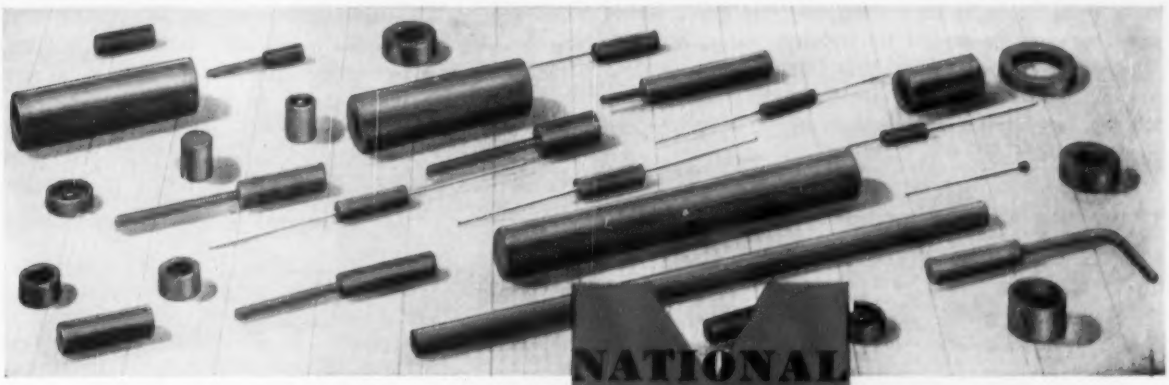
Long established firms like MOLDITE, with their vast contributions to research and development of new cores and core materials, with their advanced production and testing techniques, are greatly responsible for raising the worlds standards for quality cores, molded coil forms, and ferrites. Every business has its Johnny-come-lately's without the backround and goodwill that we at MOLDITE cherish and protect every day.

When you want cores you can trust, that will guarantee the high quality of your equipment,

MOLDITE

is ready to serve you.

ALWAYS DELIVERS A HIGH QUALITY PRODUCT



Send for our Catalog 120

IRON CORES • FERRITES • MOLDED COIL FORMS • E E CORES

NATIONAL MOLDITE COMPANY

1410 Chestnut Avenue
Hillside 5, New Jersey

Robert T. Murray Co.
604 Central Avenue
East Orange, N. J.

Jerry Golten Co.
2750 W. North Ave.
Chicago 22, Ill.

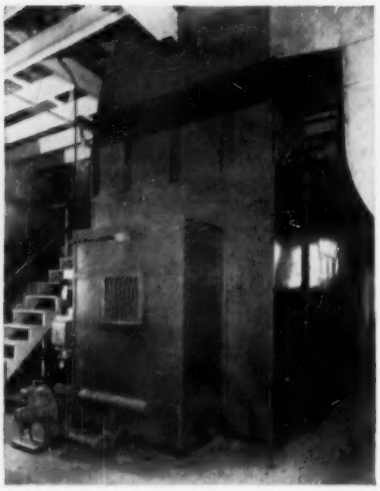
William A. Franklin
3 Holly Road
North Syracuse, N. Y.

Jose Luis Ponte
Cardoba 1472
Buenos Aires

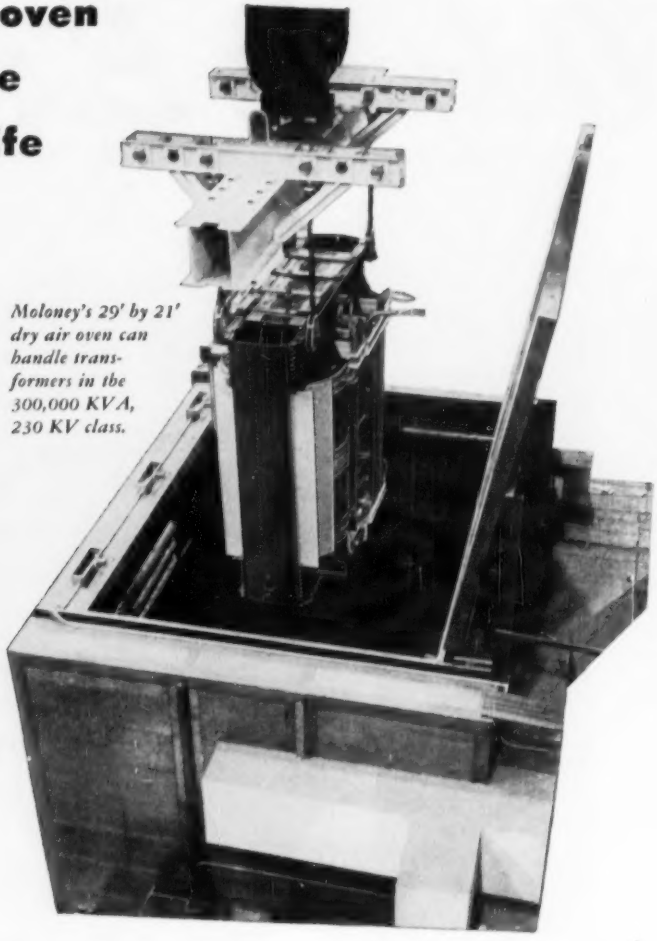
Perlmuth-Colman & Assoc.
2419 South Grand Ave.
Los Angeles Col.

John S. Plewes Co
52 Humbercrest Blvd.
Toronto 9, Ontario

Moloney power transformers are dried in new controlled atmosphere oven to further improve performance and life



A Type CH Lectrodryer like this does the DRYing.



Moloney's 29' by 21' dry air oven can handle transformers in the 300,000 KVA, 230 KV class.

Air fed to oven by Lectrodryer* contains only 1/10th grain of water per cubic foot

In expanding facilities for building the giant power transformers demanded by industry today, Moloney Electric Company added this DRY air oven at their St. Louis, Missouri plant. DRY, constant temperature air is circulated through it at 25,000 cfm. to speed insulation drying.

The extra DRYness of insulation obtained in this oven improves the performance of their transformers, increases dependability and assures longer useful life.

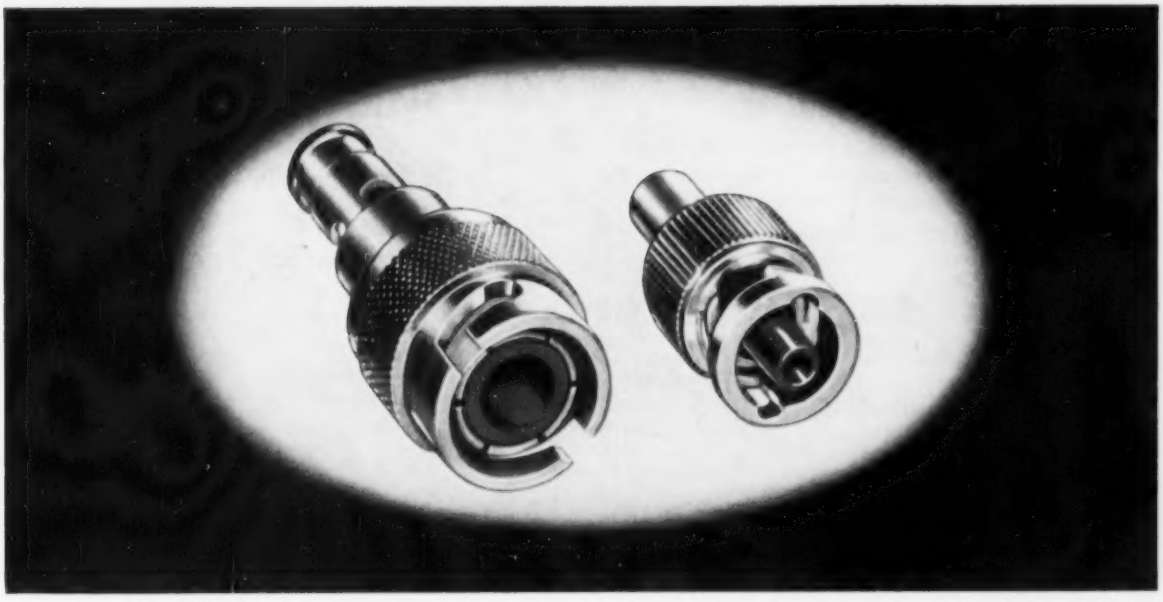
Lectrodryers are being used elsewhere in the electrical industry to equal advantage, speeding production, safeguarding materials in storage, improving quality. Some of the newer precision electronic products couldn't be made without the extreme DRYness provided by Lectrodryers. For advice on where you may use them, write Pittsburgh Lectrodryer Company, 359 32nd Street, Pittsburgh 30, Pennsylvania (a McGraw Electric Company Division).

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

* REGISTERED TRADEMARK U. S. PAT. OFF.



PRECISION CONNECTORS with KEL-F plastic parts have high RF insulation and dimensional stability. Plastic's high impact and compressive strength permit rough handling without chipping, cracking, or deforming. Zero moisture absorption and anti-adhesive surface prevent formation of conductive residue.

KEL-F® FLUOROCARBON PLASTIC

permits components to operate over a wider temperature range . . . under highly humid and corrosive atmospheres

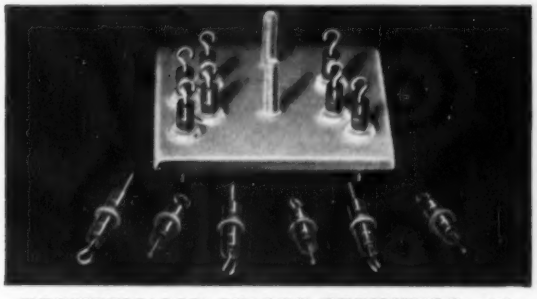
KEL-F plastic's unique combination of properties can help your product meet more rigid performance specifications. Because of the extreme stability of the fluorocarbon plastic molecule, this dense, tough thermoplastic has superior dielectric properties, excellent resistance to corrosive chemicals, outstanding thermal and dimensional stability, and zero moisture absorption.

Molded and extruded parts operate over an extremely wide range of temperatures (−320° F. to 390° F.) . . . are unaffected by humidity or operational vibration. Metal inserts, lugs and contacts are held firmly, forming a hermetic seal.

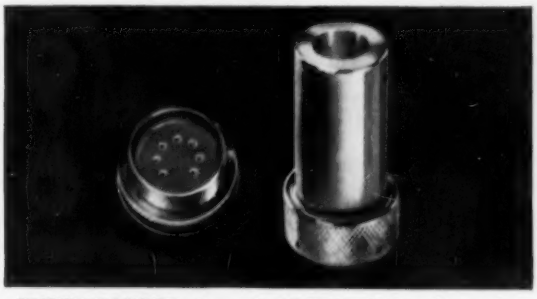
KEL-F plastic is available from Kellogg as a molding material, or in sheets, rods, strips, tubing, film and "spaghetti" from qualified fabricators and molders throughout the country. For further information, write: The M. W. Kellogg Company, Chemical Manufacturing Division, P. O. Box 469, Jersey City 3, N. J.

KELLOGG *Subsidiary of Pullman Incorporated*

® Registered trademark of
The M. W. Kellogg Company for its fluorocarbon products.

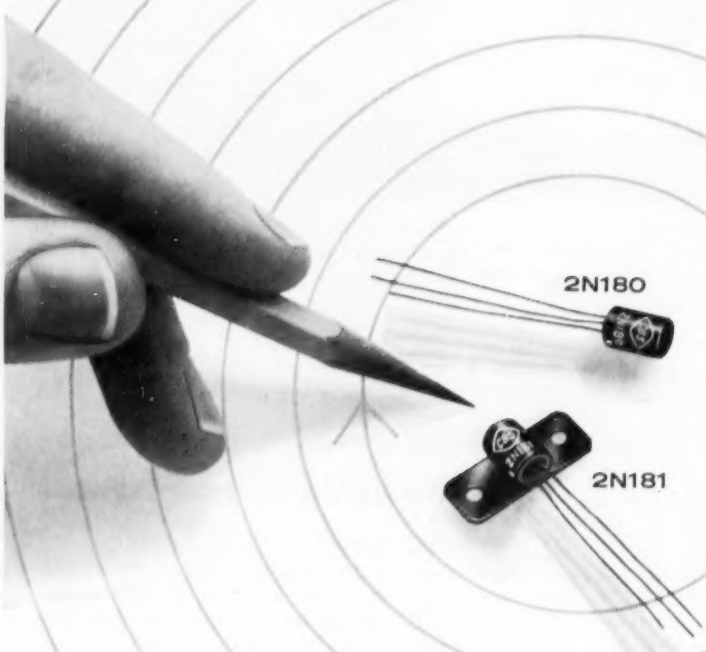


HERMETICALLY-SEALED TERMINALS with KEL-F plastic insulation handle high voltage without flash-over or tracking. Won't shrink, swell, age or lose hermetic seal at high and low operating temperatures. Can be used in contact with highly corrosive chemicals.



TUBE SOCKETS of tough KEL-F plastic. Hermetic seal defies thermal cycling, aging and humidity. Withstands high shock loads without chipping or cracking insulation. Plastic's high dielectric strength prevents shorting or arc-over at high altitudes.

Two new general-purpose CBS transistors



The versatile CBS 2N180 and 2N181 are particularly useful in audio driver and output amplifiers . . . servo amplifiers . . . computers . . . and military equipment. These medium-power PNP junction transistors offer high and uniform gain at high current levels.

The 150 mw dissipation of the 2N180 permits outputs of 75 mw in Class A and 300 mw for a pair in Class B. The generous dissipation rating is achieved with all elements of the 2N180 insulated from its case for flexible circuitry. The 2N181 version has an integral C clamp for attachment to a heat sink. This increases its dissipation rating to 250 mw, giving outputs up to 600 mw in Class B.

Like all CBS semiconductor products, the CBS 2N180 and 2N181 are processed, not just selected, to tight specifications. Their round metal cases help to make possible closer tolerances and more dependable hermetic seals. Put these versatile and reliable high-gain transistors to work in low-frequency amplifiers and switching equipment. Write today for bulletin E-264 giving complete information on the CBS 2N180 and 2N181.

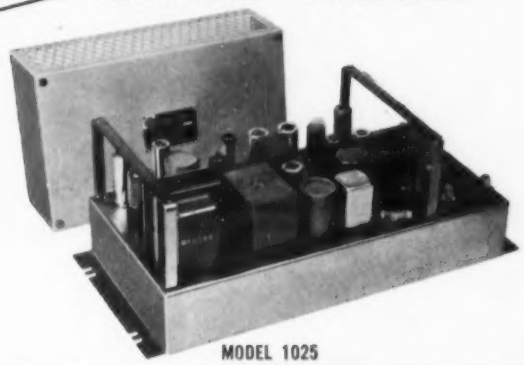
CBS semiconductors

Reliable products through Advanced-Engineering

CBS-HYTRON, Danvers, Mass.
A Division of Columbia Broadcasting System, Inc.

Telemetering and Telegraph Terminals

Frequency Type
NEW Telemeter Terminal



MODEL 1025

Model 1025

Highly Accurate, Fast Acting, Frequency Type Telemeter for Transmission over Wire Lines, Microwave, and Power Line Carrier

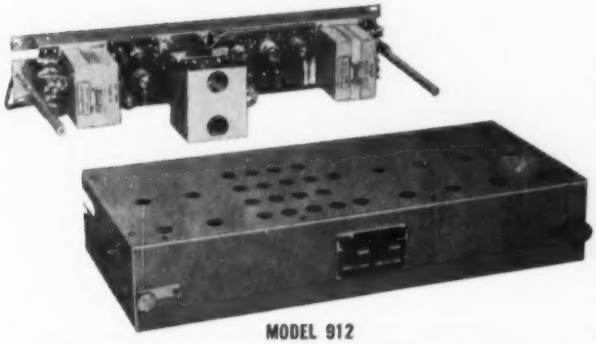
APPLICATION

The Model 1025 Telemeter Transmitter and Model 1090 Telemeter Receiver will accurately telemeter electrical and mechanical variables which can be converted into a DC voltage or will actuate a slidewire, potentiometer, etc. Quantities such as temperature, speed, pressure, flow, volts, amperes, watts, vars, etc., are only a few of the many quantities which can be telemetered accurately and instantaneously.

DESCRIPTION

The Model 1025 first converts the DC voltages to a proportional 10-30 cycle frequency which, in turn, modulates a built-in audio frequency carrier. Approximately 45 individual carrier channels are available in the frequency range of 765 cps to 20 kc for simultaneous telemetering over a single communication link. Relay output for power line carrier keying and 10 to 30 cps AC output are also available.

Comvor
Data Transmission Terminal



MODEL 912

Model 912

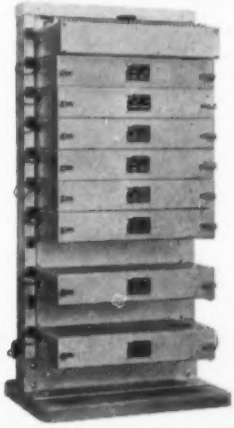
Audio Frequency Shift Terminal for Telemetering and Supervisory Control

APPLICATION

The Comvor may be employed for data transmission, signaling, telephone dialing, telemetering, and supervisory control. Through multiple use of the equipment, information from more than sixty individual functions may be simultaneously transmitted over a single communication facility. In control applications dials, stepping switches, and relay pyramids may be used in conjunction with the equipment for the control of a virtually unlimited number of functions.

DESCRIPTION

The Model 912 Comvor is a low cost audio frequency shift terminal designed for continuous reliable operation. Each equipment contains its own power supply and is available as either a transceiver, dual transmitter or dual receiver. Electrical specifications: 22 channels from 300 to 3000 cps, 38 additional channels from 3200 to 20,000 cps; power source 115 v, 50/60 cps, 35 to 45 watts; receiver — 600 ohm filter input, 0 to —40 dbm level, 60 ma loop current; transmitter — 600 ohm filter output —30 to —10 dbm output levels.



MODEL 995

Comtel
Telegraph Terminal

POWER SOURCE
115 v ±10%, 50/60 cps.
35-45 watts

AC SIGNAL LINE
600 ohms nominal

SIGNAL LEVELS
Receiver input: 0 to —40 dbm.
Transmitter output: —20 to 0 dbm

Model 995

Low cost Telegraph Terminal for keying speeds up to 100 words-per-minute

APPLICATION

The Comtel may be used in simplex, half-duplex, full-duplex, and multiplex telegraph systems. It is capable of handling keying speeds up to 100 words-per-minute with less than 10% distortion. Fourteen channels with a frequency shift of 85 cps are available in the voice band from 720 to 3017 cps. It may be applied to all common communication facilities and will perform with satisfaction under conditions of noise and varying signal levels.

DESCRIPTION

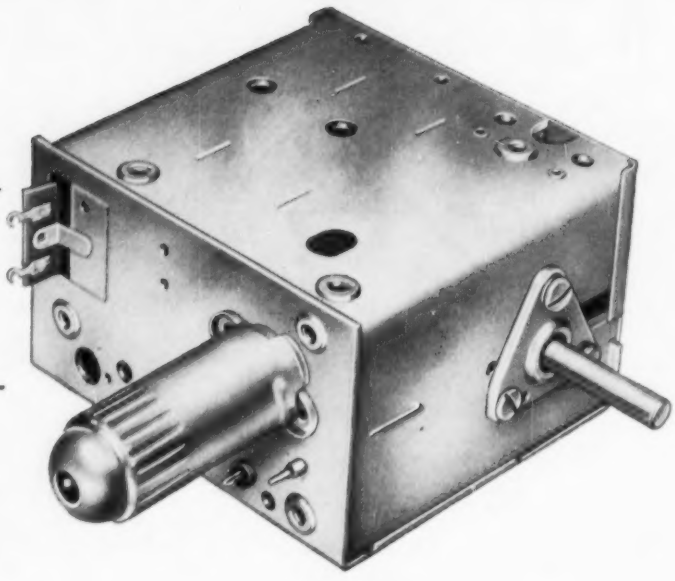
Each equipment contains its own power and loop supply and is available in either transceiver, dual transmitter or dual receiver. The unit is completely electronic and requires no relays. All essential controls such as transmitter output level, receiver input level, and bias are included.

Prices are FOB Boonton, N. J. Descriptive literature on each product is available. Telephone: DEerfield 4-3100

Radio Frequency Laboratories, Inc. BOONTON 3, N.J., U.S.A.

DESIGNERS AND MANUFACTURERS OF COMMUNICATIONS EQUIPMENT SINCE 1922

U
H
F



how we cut tuner costs without cutting quality corners

The hotly competitive TV market has long wanted high quality tuners at low prices. But everytime we took a production tuner and cut enough circuit and package "corners" to effect a significant price cut, we wound up with a product unworthy of our R/C trademark.

But last year we had our Engineering Department design a new series of tuners from scratch . . . requesting top performance and bottom costs. What we got was remarkable performance —better than requested—but no appreciable price differential. Until production got into the act, that is. Production designed and sold management on setting up a line of mechanized production equipment. And that equipment brought costs down to the desired level.

The result is evident in the T-90 uhf TV tuner illustrated. Double-circuit tuned, it features oscillator radiation fixes . . . meets all RETMA spurious radiation requirements. Performance is just what you would expect from Radio Condenser, *but the T-90 costs you far less than any previous R/C uhf tuner!*

If you want information on the new R/C line of low cost tuners, we'll be happy to have one of our engineers call at your convenience.

Get Complete Engineering and Performance Data.
Write Radio Condenser for your free copy of Bulletin T-90

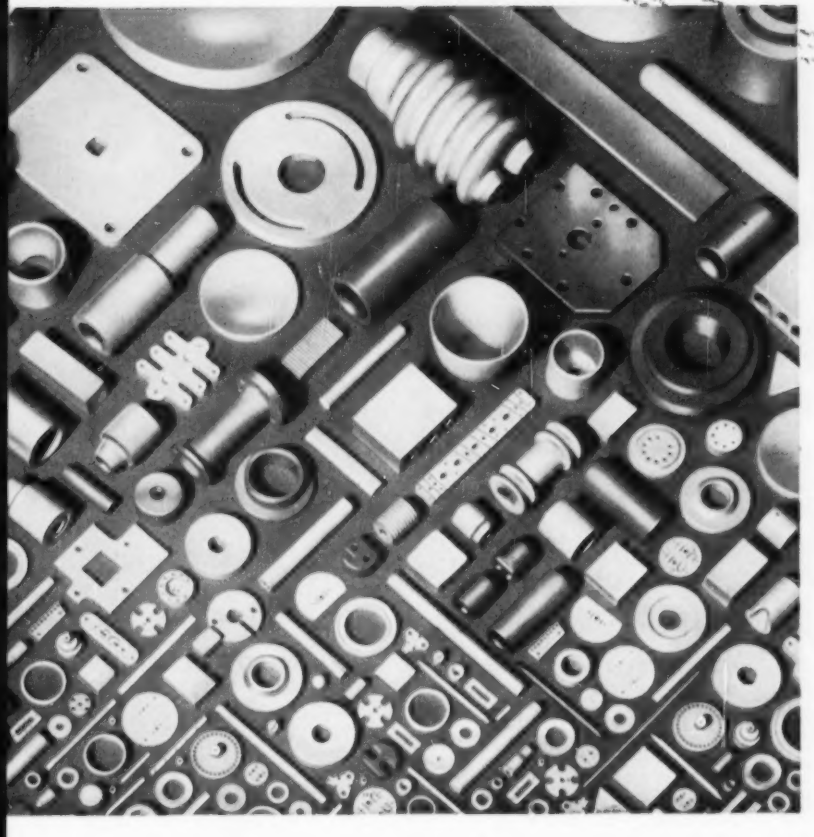
R/C

RADIO CONDENSER CO.

Davis & Copewood Streets • Camden 3, New Jersey
EXPORT: Radio Condenser Co., International Div., 15 Moore St., N.Y. 4, N.Y.
CABLE: MINTHORNE
CANADA: Radio Condenser Co. Ltd., 6 Bermondsey Rd., Toronto, Ontario

Want more information? Use post card on last page.

Improve your product with ALSIMAG® ALUMINA CERAMICS



STRENGTH. High compressive, flexural and tensile strengths.

STABILITY. Successfully withstand radiation bombardments and elevated temperatures without producing contaminants.

HARDNESS. Extremely hard, 9 on Mohs' scale. Resist wear and abrasion of most known materials.

UNIFORMITY. Manufactured under the most rigid standards of Quality Control. Shipped within your tolerance spread.

RUGGEDNESS. Resist mechanical shock, vibration and high ambient or operating temperatures.

CHEMICAL INERTNESS. Will not rust, corrode or deteriorate with time.

PRECISION TOLERANCES. Can be fabricated to extremely close tolerances on dimensions. Parts as thin as .009" are practical in production quantities.

SURFACE FINISHES. Surfaces may be ground or polished to 10 micro-inches RMS or better.

HEAT SHOCK RESISTANCE. Not affected by elevated temperatures. Withstand repeated hot-cold shock.

THERMAL CONDUCTIVITY. Dissipate heat by rapid thermal conduction.

SUPERIOR ELECTRICAL CHARACTERISTICS. Markedly superior electrical characteristics even at extremely high frequencies and elevated temperatures.

THE ANSWER TO YOUR PRODUCTION PROBLEMS MAY BE ALSIMAG ALUMINA CERAMICS! Why not investigate? Send us a blueprint or sketch along with details of your operating procedure, for complete details. Special Alumina Bulletin on Request.

PLANTWIDE VACATION
First two Weeks of July

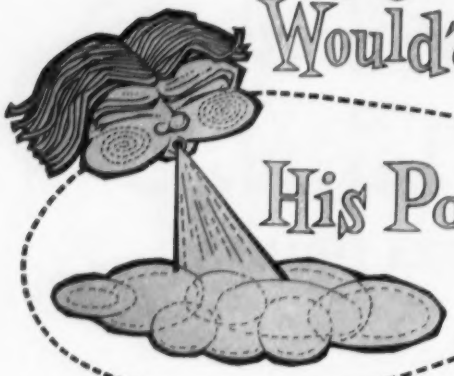
55TH YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE
A Subsidiary of
Minnesota Mining and Manufacturing Company

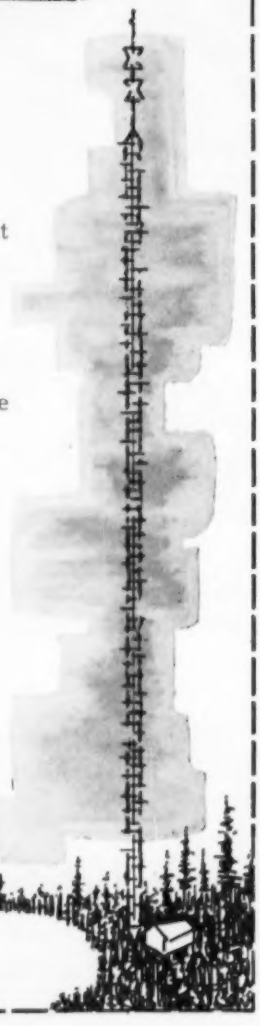
Branch offices in these cities (see your local telephone directory): Cambridge, Mass. • Chicago, Ill. • Cleveland, Ohio • Dallas-Houston, Texas • Indianapolis, Ind. • Los Angeles, Calif. • Newark, N. J. • Philadelphia, Pa. • St. Louis, Mo. • South San Francisco, Calif. • Syracuse, N. Y. • Tulsa, Okla. **Canada:** Irvington Varnish & Insulator Div., Minnesota Mining & Mfg. of Canada, Ltd., P. O. Box 757, London, Ontario. **All other export:** Minnesota Mining & Mfg. Co., International Division, 99 Park Ave., New York, N. Y.

Magellan Would'a Fractured His Poopdeck



. . . matching TOWER'S Log!

FERDINANDO MAGELLAN was quite a fiddle-foot in his day, but he was an amateur compared with TOWER construction crews. History records that old Ferd and his men traveled approximately 27,000 miles on their global circumnavigation. TOWER crews have virtually traced and retraced this journey 27 times, while erecting more than 2,000 tower installations around the world. TOWER installations are serving in corners of the globe Magellan never dreamed existed . . . like Reykjavik, Thule, and Okinawa. So, no matter what or where your tower problems are, TOWER will solve them for you . . . on time and according to your exact specifications.



Write for free illustrated booklet

TOWER

tower fabricators and erectors the world over

CONSTRUCTION CO.

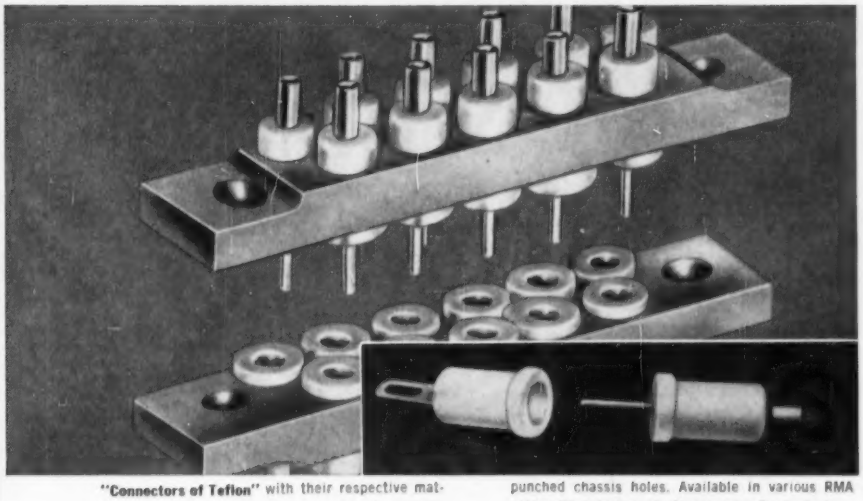
Sioux City, Iowa

DU PONT
Better Things for Better Living
. . . through Chemistry

ELECTRONIC DESIGN NEWS

PROPERTY AND APPLICATION DATA
ON THESE VERSATILE ENGINEERING MATERIALS:
"ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Electronic connectors of Du Pont TEFLON® unaffected by temperature changes, humidity and mechanical shock



"Connectors of Teflon" with their respective mating parts. Male and female connector pins can be compression-mounted directly into drilled or punched chassis holes. Available in various RMA colors. (Manufactured by Fluorocarbon Products, Inc., Division of United States Gasket Co., Camden 1, N. J.)

New connectors with bodies of "Teflon" are designed for low-loss, high-frequency service in interconnection of radio, radar and other electronic equipment—where connectors are subjected to a wide range of temperatures, pressure, humidity and mechanical shock and vibration.

Continuous current rating is 3 amp. for .040 pins and 5 amp. for .063 pins. Voltage rating is 3,300 V. RMS (short time test at sea level).

Du Pont "Teflon" tetrafluoroethylene resin was selected for this particular insulation job because of its unique properties. In this application, it is serviceable at temperatures from −110°F. and operates in pressure altitudes from sea level to 60,000 ft. It has zero water absorption by ASTM test D570-42.

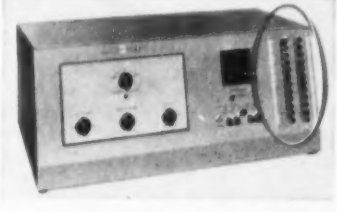
"Teflon" is nonflammable and will not carbonize under arcing; it has good dielectric strength. Resiliency of "Teflon" enables the insulation to expand to original diameter after it is pressed into the hole—and locks the connector securely and permanently in place.

Have you investigated the possibilities for "Teflon" in your electronic design application? Do you require material that is chemically inert, suitable for use at extreme temperatures of −450°F. to 500°F., tough and resilient? For complete property data on this versatile Du Pont engineering material, mail the coupon below.

Laminations of TEFLON® for printed circuit bases

Typical uses for laminations of glass cloth and Du Pont "Teflon" tetrafluoroethylene resin include: conductor and ground insulation, hookup wire, power cable, printed circuit bases and structural parts. The laminations combine the dielectric properties, chemical inertness and heat resistance of "Teflon" with the tensile strength, resistance to cut-through, and resistance to creep of woven glass fiber.

An informative free bulletin describing the preparation and uses of laminations and impregnations of glass cloth employing "Teflon" tetrafluoroethylene resin is now available. Specify Bulletin X-64.



Magnifying lens of LUCITE® for Stromberg-Carlson communication-system control panel. Names or numbers under the lens are magnified with maximum optical clarity—easily visible from a distance. "Lucite" resists cracking, crazing and chipping and is unaffected by age. (Lens extruded by Anchor Plastics Co., Long Island City, New York.)

SEND FOR MORE INFORMATION

For complete details that will help you further evaluate the Du Pont engineering materials for use in your product-development programs, mail the coupon at the right. Specific property and application data will be sent to you.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department
Room 224 Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada Limited, P.O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: "Teflon"* ☐, "Lucite"* ☐. I am interested in evaluating these materials for _____

_____

Name _____ *Position* _____

Company _____

Street _____ *City* _____ *State* _____

Type of Business _____

**Registered trademark of E. I. du Pont de Nemours & Co. (Inc.)*

versatile

Multi-channel -- telegraph A1 or telephone A3.

FROM GROUND TO AIR OR POINT TO POINT

STABLE

High stability (.003%) under normal operating conditions.

RUGGED

Components conservatively rated. Completely tropicalized.

Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-24.0 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3. Stability .003%. Operates in ambient −35° to 45°C. Nominal 220 volt, 50/60 cycle supply. Conservatively rated, sturdily constructed. Complete technical data on request.

Here's the ideal general-purpose high-frequency transmitter! Model 446... 4-channel, 6-frequency, medium power, high stability. Suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Co-axial fitting to accept frequency shift signals.

Now! Complete-package, lightweight airborne communications equipment by Aer-O-Com! Write us today for details!

AER-O-COM

3090 DOUGLAS ROAD MIAMI 33, FLA.

from **Transitron**

SILICON RECTIFIERS

STUD MOUNTED

LEAD MOUNTED

MINIATURE

No matter which mounting you prefer. . . . Reliability is assured

Transitron's silicon rectifiers are now available with both lead and stud mountings. The three versions now in production provide a current range from 100 ma to 1 ampere. Their small size and high temperature characteristics make them ideal for missile, aircraft or other applications where reliability is of prime importance.

RATINGS AT 135°C*

	Peak Recurrent Inverse Voltage (volts)	Maximum Average Forward Current (ma)	Peak Recurrent Forward Current (amps)
1N253 *	95	1000	4.0
1N254 *	190	400	1.2
1N255 *	380	400	1.2
1N256 *	570	200	0.6

See Bulletin TE1321, 1336 for additional types and complete specifications.

RATINGS AT 100°C AMBIENT

	Peak Recurrent Inverse Voltage (volts)	Maximum Average Forward Current (ma)	Peak Recurrent Forward Current (amps)
TL12	100	350	2.0
TL22	200	350	2.0
TL42	400	350	2.0
TL61	600	200	1.0

See Bulletin TE1335 for additional types and complete specifications.

RATINGS AT 100°C AMBIENT

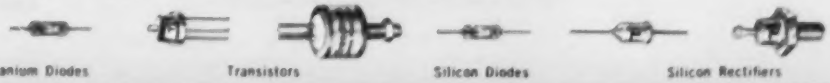
	Peak Recurrent Inverse Voltage (volts)	Maximum Average Forward Current (ma)	Peak Recurrent Forward Current (ma)
TJ- 5	50	100	500
TJ-10	100	100	500
TJ-20	200	100	500
TJ-30	300	100	500

See Bulletin TE1338 for additional types and complete specifications.

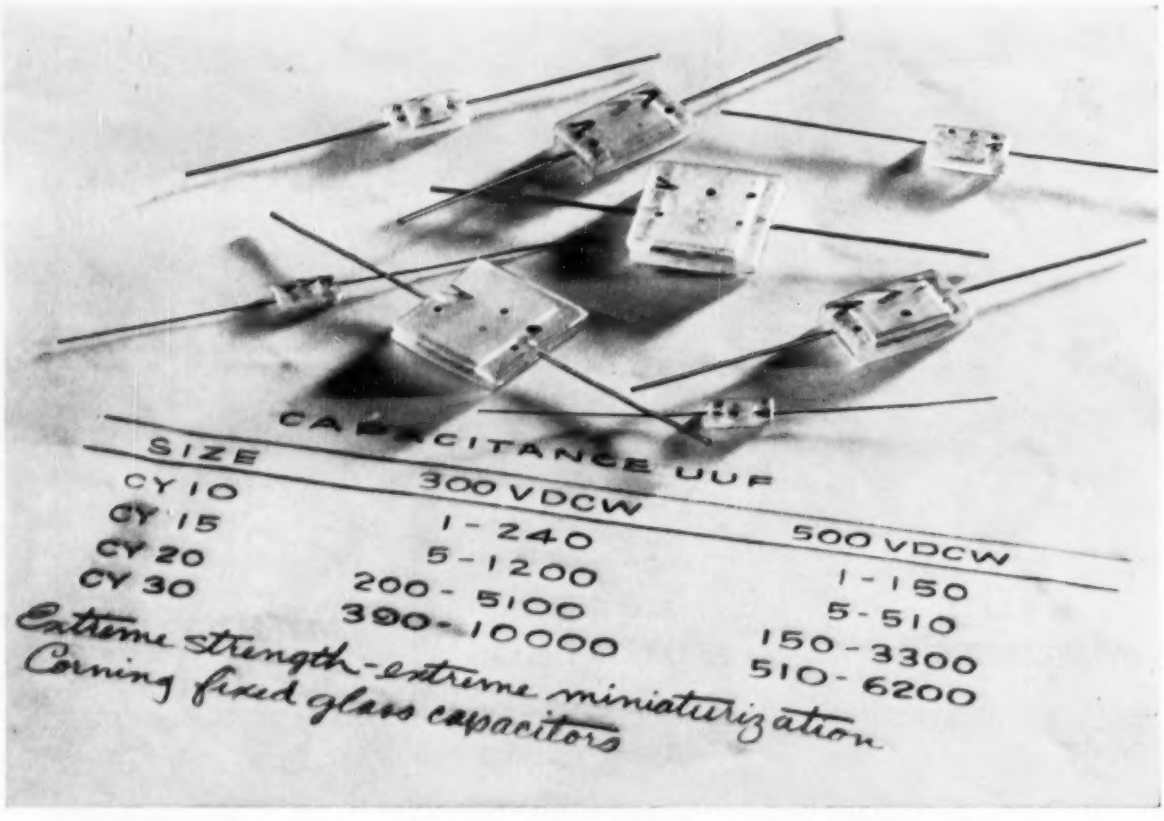
* JAN types

Transitron

electronic corporation melrose 76, massachusetts



Germanium Diodes | Transistors | Silicon Diodes | Silicon Rectifiers



You'd have to smash a Corning Capacitor before you could alter its values by mechanical shock

That's how rugged these miniature fixed glass capacitors are. ("Miniature" means about one-third smaller than other kinds of equal capacitance.)

Their strength comes from the way we make them. Layers of conductor and dielectric are sealed together under heat and pressure into a monolithic structure. No mechanical shock short of shattering the seal alters the value. Speaking of values, the table illustrated above shows them.

Because everything is sealed in the same material as the dielectric, nothing outside can get inside.

You can use these capacitors to temperatures of 125° C. and higher with proper voltage derating. Even after repeated temperature cycling, the TC remains the same. And TC stays within close limits over a wide temperature range, varies little between capacitors. Capacitance drift is so close to zero that it's generally less than the error of measurement.

We can make capacitors to your electrical and physical specifications over an unusually varied range. Single, self-supported units can be designed for high voltages or high capacitances. Series parallel combinations still further extend the range.

Circle the reader service of this publication, or write direct for more information about Corning Fixed Glass Capacitors, prices and samples.

Ask for information on these other Corning Capacitors:

Medium Power Transmitting—CY-60 and CY70. Ideal for mobile RF transmitters.

Canned High Capacitance—provide the advantages of rugged glass design to your specifications.

Subminiature Tab-Lead—up to 90% less volume compared to pigtail types. To your specifications.

Special Combinations—the performance and benefits of glass in infinite shapes, sizes and leads. To custom order.

Other electronic products by Corning Components Department:

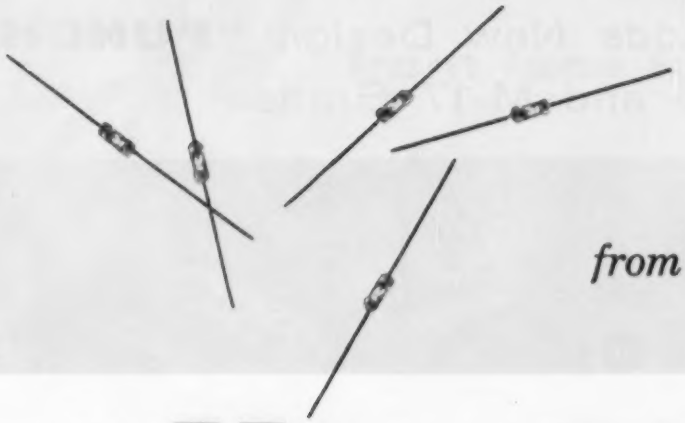
Fixed Glass Capacitors*, Transmitting Capacitors, Canned High-Capacitance Capacitors, Subminiature Tab-Lead Capacitors, Special Combination Capacitors, Direct-Traverse and Midget-Rotary Capacitors*, Metallized Glass Inductances, Resistors.

Distributed by Erie Resistor Corporation

CORNING GLASS WORKS, 94-4 Crystal Street **CORNING, N. Y.**

Components Department, Electrical Products Division

Corning means research in Glass



from **Transitron**

new MILITARY *type* GOLD BONDED Diodes

1N270* — The 1N270 is designed for efficient core switching. It features 200 ma at +1-V.

1N277* — The 1N277 is recommended for critical high temperature applications. It replaces the existing military types 1N127, 1N198, 1N38A and 1N70.

1N281* — The 1N281 offers 40 ma at +1-V, and replaces the existing military types 1N126 and 1N69.

The proven performance and superior characteristics of gold bonded diodes are now incorporated in three new military types.

The 1N270, 1N277 and 1N281 are preferred types for new design.

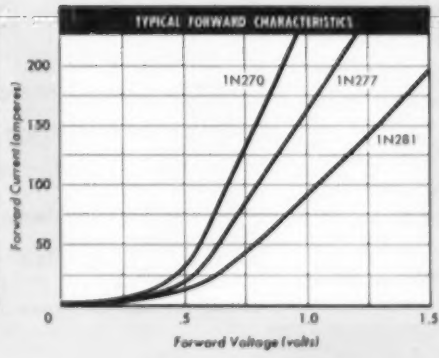
Transitron's gold bonded diodes are characterized by reliability under the most severe operating conditions. This is achieved by rugged construction and 100% testing of electrical and mechanical characteristics.

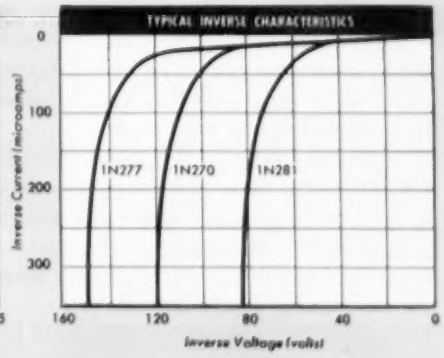
WRITE FOR BULLETIN TE-1319.

SPECIFICATIONS AT 25°C

	Forward Current at +1V (ma)	Inverse Current at Specified Voltage (ua @ volts)	Maximum Operating Voltage (volts)
1N270*	200	100 @ -50V 75 @ -10V at 75°C	80
1N277*	100	250 @ -50V at 75°C 75 @ -10V at 75°C	100
1N281*	40	500 @ -50V 30 @ -10V	60

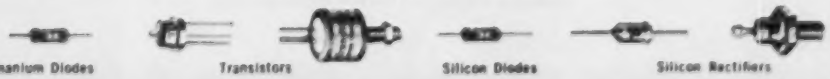
***JAN types**



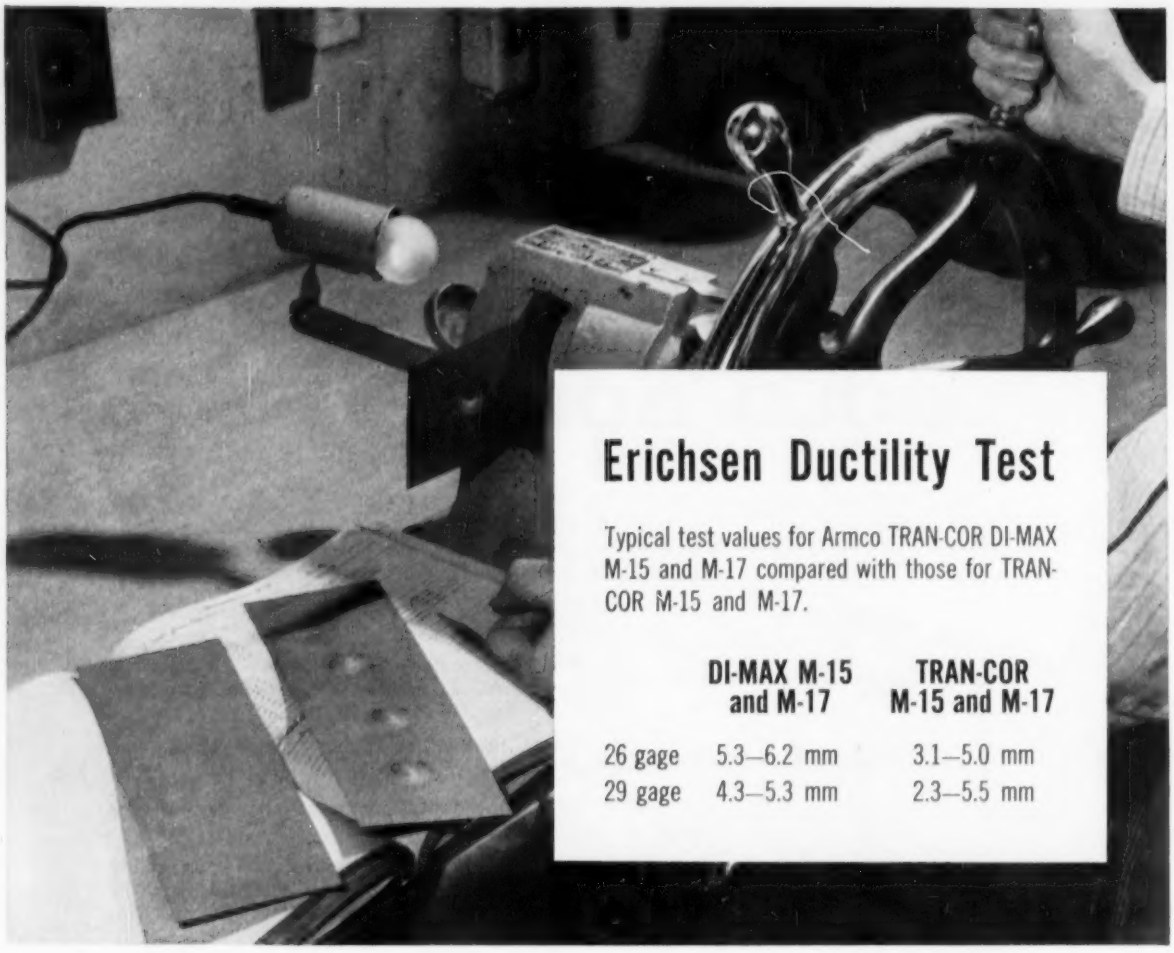


Transitron

electronic corporation melrose 76, massachusetts



Armco DI-MAX Adds New Design **"PUNCH"** to M-15 and M-17 Grades



Erichsen Ductility Test

Typical test values for Armco TRAN-COR DI-MAX M-15 and M-17 compared with those for TRAN-COR M-15 and M-17.

	DI-MAX M-15 and M-17	TRAN-COR M-15 and M-17
26 gage	5.3—6.2 mm	3.1—5.0 mm
29 gage	4.3—5.3 mm	2.3—5.5 mm

Armco's DI-MAX process now offers a new design advantage in the low core loss M-15 and M-17 electrical steels. Better, more uniform ductility now makes it possible for designers to use punched laminations where they need the low core losses of these grades.

Besides punchability, Armco TRAN-COR DI-MAX M-15 and M-17 offer other performance-improving properties. In large motors and generators, induction regulators, TV power transformers and other applications calling for segmented, "E" and "I" or rectangular laminations, here are some of the plus factors you get:

- **Better permeability at high inductions**
- **Greater gage uniformity**
- **Better space factor**
- **Smoother surface**
- **Improved flatness**

For complete information on how DI-MAX M-15 and M-17 can help you design and produce more efficient electrical equipment, write us at the address below or phone the nearest Armco Sales Office.

ARMCO STEEL CORPORATION

1146 CURTIS STREET, MIDDLETOWN, OHIO

ARMCO

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

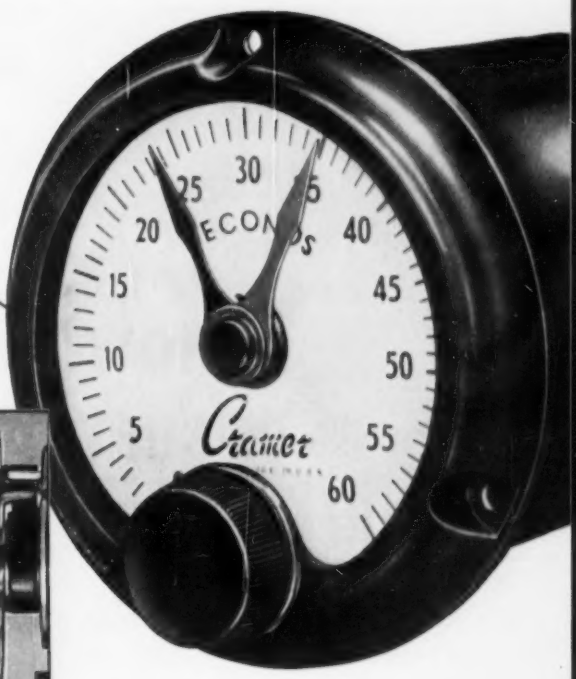
NEW

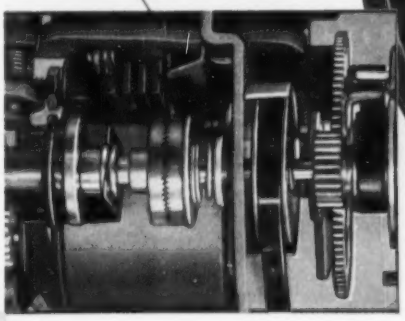
from face to terminal block

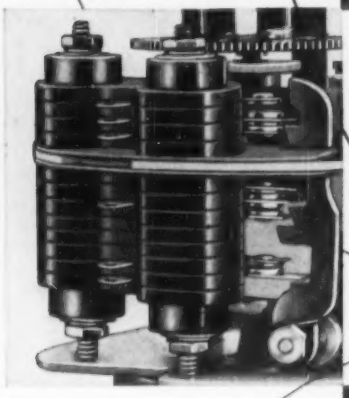
Cramer

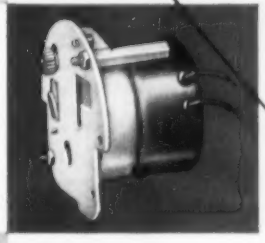
type 412

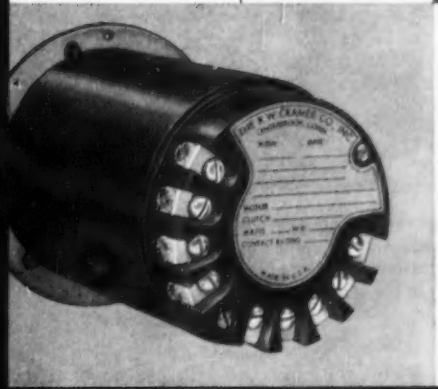
TIME DELAY RELAY











NEW—Repeat Accuracy within ± ¼ of 1% of full scale (30 sec. and longer ranges); ± ½ of 1% on faster timers.

NEW—Full Vision Dial. 300 degree scale assures precise settings and fast, accurate readings. Dial and pointers protected by transparent cover.

NEW Contacts, rated 15 amps., give positive quick-make, quick-break operation. Contacts are of silver cadmium oxide with ability to handle high inrush currents.

NEW Flexibility in wiring. Nine-position terminal block offers side or rear connection, presents a variety of wiring possibilities.

NEW Reset Shock Spring Design laboratory tested for more than a million operations.

NEW Friction Setting Mechanism allows adjustment even while timer is operating.

NEW—Ratchet Clutch operated by powerful relay, provides instant action, no slip.

NEW O-Ring Retainer permits quick removal of bakelite housing, exposing entire timer mechanism.

Timer driven by high torque (30 in. oz. at 1 r.p.m.) Cramer Type 112 Synchronous Motor.

Cramer TIMING DEVICES

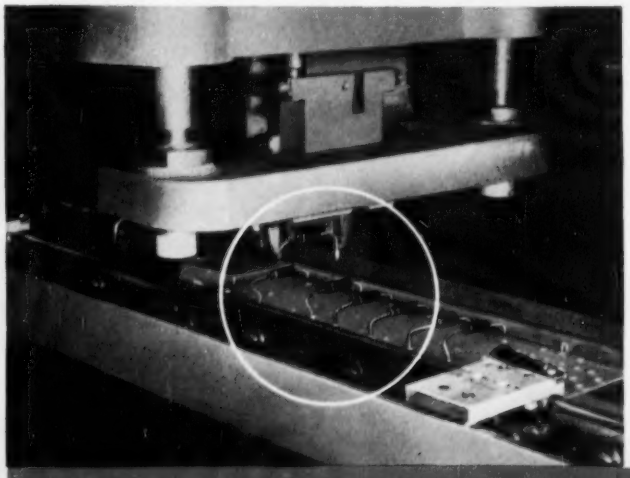
The R. W. CRAMER CO., Inc.

SPECIALISTS IN TIME CONTROL

BOX 3, CENTERBROOK, CONNECTICUT

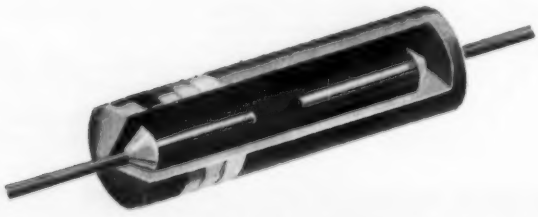
60C833

Unique method of anchoring IRC leads keeps them from being twisted or pulled out in automatic bending and insertion operations.



HOW TO BE SURE OF TERMINAL SECURITY

No matter how you assemble or solder them, IRC resistors provide the extra terminal security that prevents termination failures in the production line or in the field. Leads of IRC Type BT Resistors, for example, are uniquely anchored in the resistor body so that they won't twist or pull out. A new IRC alloy coating which overcomes copper migration also assures improved and more uniform solderability. Together, these features speed up production, cut inspection costs, and assure reliable long-range performance. For more information, send coupon today.



Why Leads Won't Come Loose

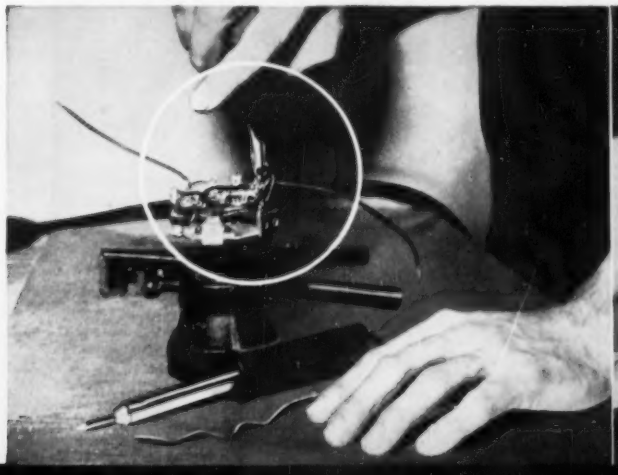
Leads of IRC Type BT Resistors are so securely joined to the element that even the unmolded assembly exceeds the standard 5-lb. pull requirement. For still greater strength, leads have a crimped collar which provides a tooth-and-notch effect when the assembly is molded as a unit.

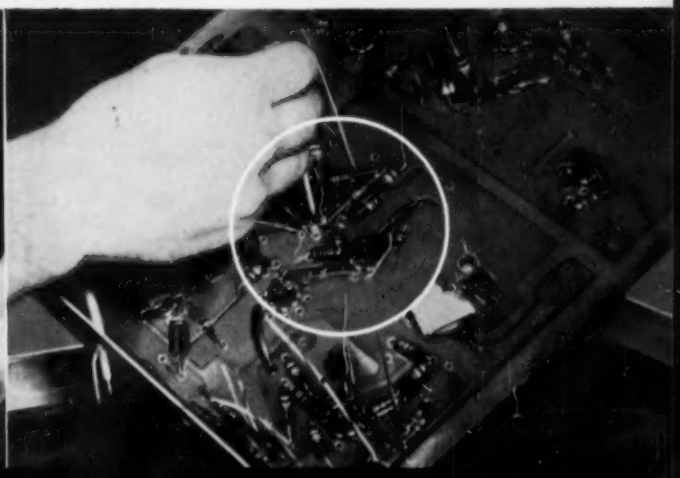
Straight Leads Speed Automation

The IRC Automation Package assures you of consistently straight leads suitable for automatic feed. This permits automatic, trouble-free feed to holding devices or into inserting heads of printed wiring lines.

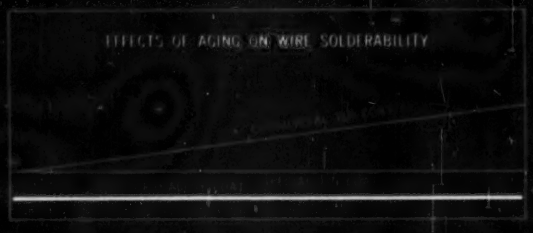
Because they can be bent up to resistor body, IRC leads solve special "fit" problems and simplify production and soldering operations.

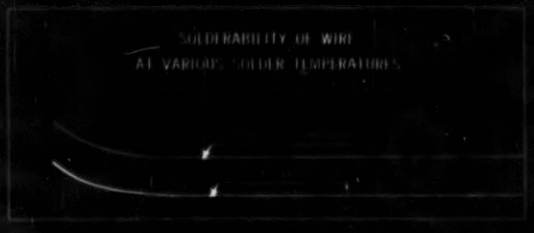
New alloy surface on leads overcomes tendency of copper to migrate toward coating. This assures superior solderability by any method, with low or varying temperatures.



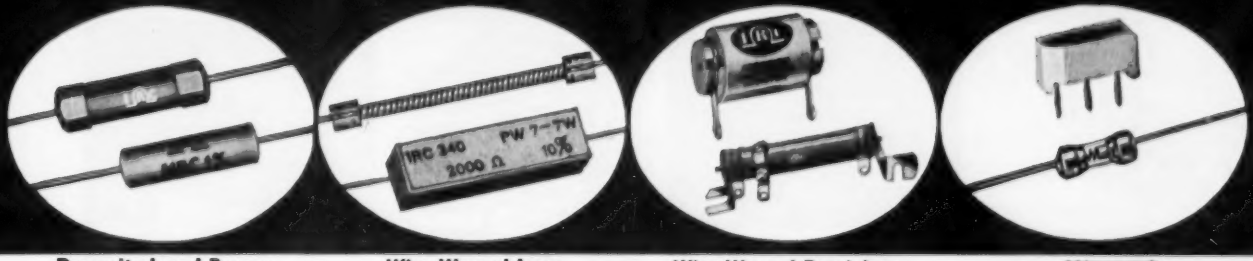


here's how much IRC's new alloy coating improves solderability





EXTRA TERMINAL SECURITY ALSO FEATURES OTHER IRC RESISTORS



Deposited and Boron-Carbon Resistors

The metal used in terminations passes ASTM tests for season cracking. In addition, terminations are automatically assembled for uniform strain strength.

Wire Wound Low Wattage Resistors

Through machine assembly, the element, terminal clips, and leads are assembled simultaneously. No other method assures such uniformly high resistance to twisting or pulling.

Wire Wound Precision and Power Resistors

Lugs can't turn or twist and break the fine resistor wire. This also eliminates any "strain gauge" effect which would change the resistance value.

Microstak Selenium Rectifiers

Miniature rectifiers and diodes with low capacitance cells as small as .060 dia. Superior characteristics and uniformity. Wide variety of types including hermetically sealed units.

Voltmeter Multipliers • Boron & Deposited Carbon Precistors • Insulated Composition Resistors • Power Resistors • Controls and Potentiometers • Low Wattage Wire Wounds • Germanium Diodes

Wherever the Circuit Says

Precision Wire Wounds • Ultra HF and Hi-Voltage Resistors • Selenium Rectifiers • Insulated Chokes • Hermetic Sealing Terminals

IRC

HYCOR DIVISION of International Resistance Co.
Los Angeles, California
CIRCUIT INSTRUMENTS INC. (IRC Subsidiary)
St. Petersburg, Florida

INTERNATIONAL RESISTANCE CO.
Dept. 233, 401 N. Broad St., Philadelphia 8, Pa.

Send data on resistors checked:

☐ Fixed Composition Resistors ☐ Deposited and Boron-Carbon Resistors ☐ Wire Wound Power Resistors ☐ Wire Wound Precision Resistors ☐ Selenium Rectifiers

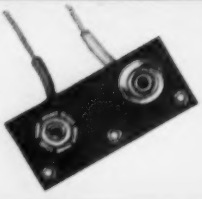
Name_____

Company_____

Address_____

City_____ State_____

Ucinite Electrical Assemblies



BATTERY CONNECTORS

Wired snap-on units for use with batteries equipped with United-Carr electrical snap fasteners. Wiring to customer's specifications.

BANANA PINS

Four sizes of plugs with one-piece beryllium copper springs. Adaptable mounting ends in threaded, staking, or solder lug types. Similar Mating Jacks also available.

SHOCK MOUNTS

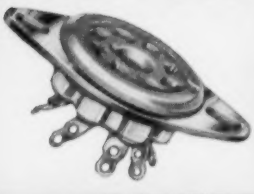
Offered in several sizes—brackets and durometer of rubber bushings can be varied. With threaded Teenuts or plain bushings. Insulated versions if needed.

ANODE CONNECTORS

Plug button contacts for positive firm connections. Corona resistant neoprene or silicon shields in straight or right angle types. Wiring to customers specifications.

TUBE CAPS

Positive gripping, heat treated steel springs in corona resistant metal housing. Insulated or non-insulated. Wired to specifications. Type shown has silicon shield for special application.

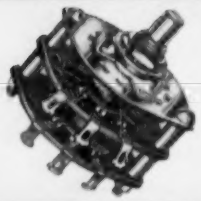


TUBE SOCKETS

Ceramic octals and special types. Ring or saddle mounting. Open ended plates for shock mounting with rubber grommets. J A N types.

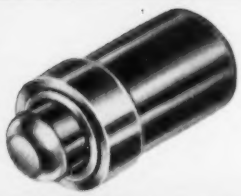
SWITCHES

Oak type switches manufactured as a licensee. Variety of rotary and push-button assemblies to specifications.



SNAP SWITCHES

Precision, momentary contact push-button switches. Small and dependable. Several circuit arrangements. Water tight version shown.



TEST JACK

Ucinite's quality jack for .080 probes. Beryllium copper contacts. Nylon insulation in colors. Metal shell for firm dependable mounting.

VIBRATION ISOLATORS

Equiflex (1 to 1 ratio) metal mounts ensure long life, fit small spaces, can be used in any direction. Three sizes, cup or plate mountings.

METAL STAMPINGS

Volume production in Metal stampings. Years of engineering and tooling skill available to solve your particular problem.

ELECTRICAL ASSEMBLIES
Ucinite
RADIO AND AUTOMOTIVE

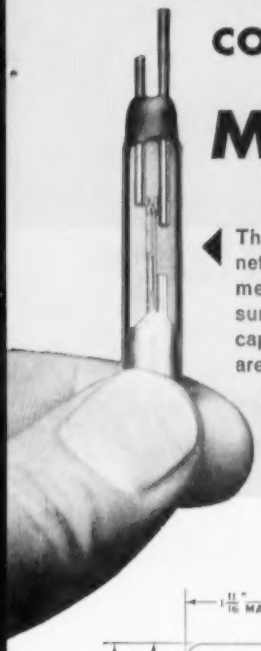
With years of specialized experience in the electronics field and complete facilities for the volume production of small metal stampings as well as the assembly of metal to plastic and ceramic components, Ucinite is fully equipped to supply you with special electrical parts and assemblies...designed, assembled, wired and marked to your specifications. For complete design, engineering and production service, call your nearest Ucinite field engineer.

The UCINITE Company

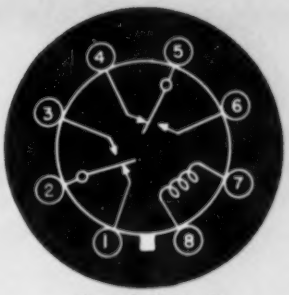
DIVISION OF UNITED-CARR FASTENER CORP.

Newtonville 60, Massachusetts

3 NEW CLARE MERCURY-WETTED CONTACT RELAYS TO HANDLE MULTIPLE CIRCUITS

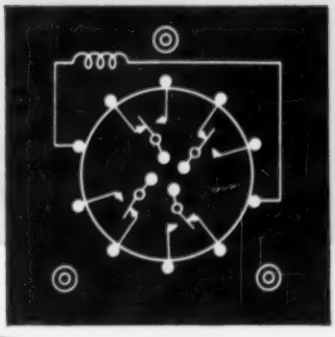


These relays contain 2, 3, or 4 magnetic switches. Each switch is hermetically sealed in a high pressure hydrogen atmosphere in a glass capsule. Platinum contact surfaces are continuously wetted with mercury by capillary connection to mercury reservoir.

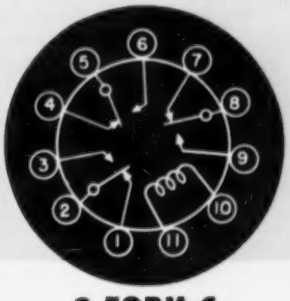


2 FORM C

TYPICAL BASE CONNECTION DIAGRAMS



4 FORM C



3 FORM C

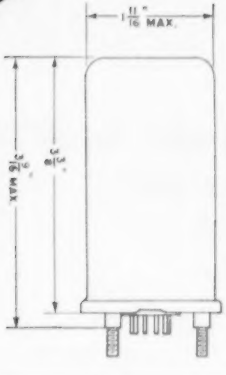


Photo and dimensional drawing of steel can in which 4 Form C switches are enclosed with coil. Plug-in header shown.

SAVE SPACE, MONEY and POWER

In applications requiring more than 1 Form C contact, a multicontact relay may be used instead of 2, 3 or 4 of the standard type HG Mercury-Wetted Contact Relays described in Sales Engineering Bulletin No. 120, thereby saving chassis space, first cost, and operating power.

ELECTRICAL FEATURES

LONG LIFE: Conservative life expectancy of over a billion operations when operated within ratings.

HIGH-SPEED: Give consistent performance at speeds up to 60 operations per second.

HIGH CURRENT—and voltage-handling capacity, up to 5 amperes, up to 500 volts; (250 volt-amperes, max.)

UNIFORMITY: Operating time varies by only about 0.1 millisecond under constant drive conditions.

NO CONTACT BOUNCE

MECHANICAL FEATURES

- Small chassis space required
- Convenient plug-in mounting
- Environment-free
- Tamperproof
- High sensitivity
- Maintenance-free
- No contact wear
- Adjustment cannot change

2 OR 3 FORM C

Photo and dimensional drawing of steel can for either 2 or 3 Form C switches. Octal base plug shown is for 2 Form C. An 11 pin base is standard for 3 Form C. Solder terminals also available.

FOR COMPLETE INFORMATION

on CLARE Mercury-Wetted Contact Relays for single or multiple circuits contact your nearest CLARE representative or address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois.

Send for CLARE Sales Engineering Bulletin No. 120

FIRST in the industrial field

CLARE RELAYS

Picture flutter from planes flying overhead is greatly reduced.

In fringe-reception areas, there is less picture roll.

Lightning will not materially affect sync—cause picture distortion.

WITH THE NEW G-E 6BU8, YOUR POPULAR-MAINTAIN PICTURE STEADINESS UNDER

New General Electric twin pentode combines sync and AGC tubes in one envelope. Costs substantially less than the pair of tubes formerly needed for picture stability.

You can score a real advance in TV picture performance with the 6BU8—new G-E 9-pin twin pentode that combines the functions of the 6BE6 and 6AU6, two tubes commonly used to assure a steady, undistorted screen image.

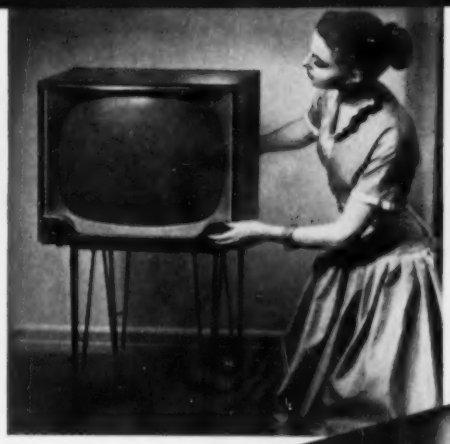
Cost of the 6BU8 is materially less than cost of the 6BE6 and 6AU6 as a pair. Consequently, you can afford to design the new tube—or Type 3BU8, its series-string counterpart—into your volume-production, popular-price television sets.

Your portables and small table models will have picture quality that is proof against flutter and distortion from passing planes, passing cars, lightning. The image will have far less roll in fringe areas . . . tuning will be "one-hand," with no need for distance switch. All these are features usually found only in deluxe TV receivers.

The 6BU8 and 3BU8 are the latest in a long series of General Electric tubes for TV that have helped set manufacturers cut costs and improve performance. Use them to increase receiver sales by upgrading picture quality over your entire line!

Complete information and prices will be sent you on request. Or, if you prefer, a G-E tube engineer will be glad to call on you in person at your convenience. *Tube Department, General Electric Company, Schenectady 5, New York.*

Passing automobiles leave the picture steady, free from distortion and jitter.

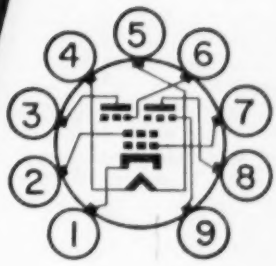


◀ **ALSO** . . . . . no more bothersome "both-hands" tuning of the set! The distance switch can be eliminated—another 6BU8 plus and cost-saver. When choosing programs, viewers no longer need manipulate two controls: tuning knob and distance switch. One control knob will tune in *all* stations, near and far.

PRICE SETS WILL ALL CONDITIONS!

6BU8 and 3BU8

9-pin twin pentodes with common connections for the screen grid, control grid, and cathode. The two types are identical except for heater voltage—6.3 v and 3.15 v respectively. Also, the 3BU8 has controlled heater warm-up time for operation in series-string television sets.

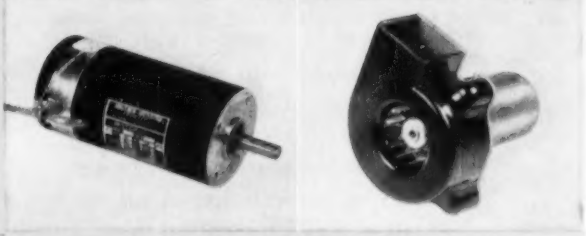


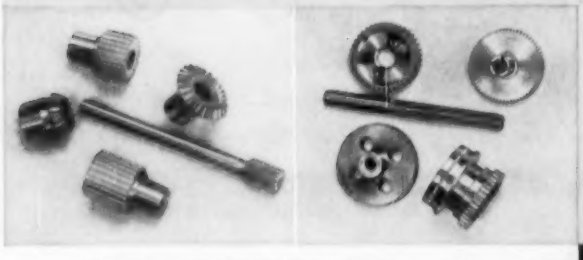
Progress Is Our Most Important Product

GENERAL ELECTRIC

how to reduce costs with WESTERN GEAR rotary electrical equipment

We have more than 50 basic prototype motors, fans, blowers, converters, alternators and generators. Motor designs range from 1/500th to 4 HP, 50 to 1,000 cycles in frequency, any desired voltage. Extensive line enables economic modification to your requirements or special design. Complete engineering service gladly offered for help on any rotary electrical equipment problem. Write for new catalog No. 254-A.





Precision fine pitch gears, constructed to the highest specifications for electronics use, available from 200 to 6 diametral pitch and from .125" to 10" diameter. Complete engineering and manufacturing facilities for the application of high precision gearing and gear drives in electronics equipment. Ask for help on your problem. No obligation!

"The difference is reliability" • Since 1888

Detail your requirement on any electronic problem. Utilize Western Gear's production facilities to cut your product costs. Our engineers will give their recommendations promptly. Address Western Gear Corporation, Electro Products Division, 132 W. Colorado St., Pasadena 1, Calif.

WESTERN GEAR *Corporation*
ENGINEERS AND MANUFACTURERS

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON — REPRESENTATIVES IN ALL PRINCIPAL CITIES

EIMAC Klystrons bring new power to another frequency range...

Eimac X563E, 5900-6400mc, and amplifier circuit assembly.

TYPICAL OPERATING CONDITIONS PER TUBE X563 KLYSTRONS

D-C Beam Voltage	2750v	Power Output	60w
D-C Beam Current	110ma	Efficiency	20%
D-C Focusing Voltage	−50v	Driving Power	5mW

Eimac X563 amplifier klystrons make 50 watt CW power output commercially available at 5400-7400mc. A bonus feature of the X563 is its adaptability to present C-Band systems. Existing milliwatt equipment is sufficient to drive a conservatively rated X563 to power gains of 10,000 times and efficiencies of 20-25%.

Single adjustment tuning knobs make each of the X563's four integral cavities as easy to tune as a standard AM broadcast receiver.

The Eimac X563 is also available with magnetic circuit components, output waveguide fitting and collector and cathode sockets comprising a suitcase-size amplifier assembly weighing only 20 pounds.

● *Eimac offers the most extensive selection of high power amplifier klystrons for pulse, CW and AM applications. For information and a copy of "KLYSTRON FACTS #3" contact our Technical Services Dept.*

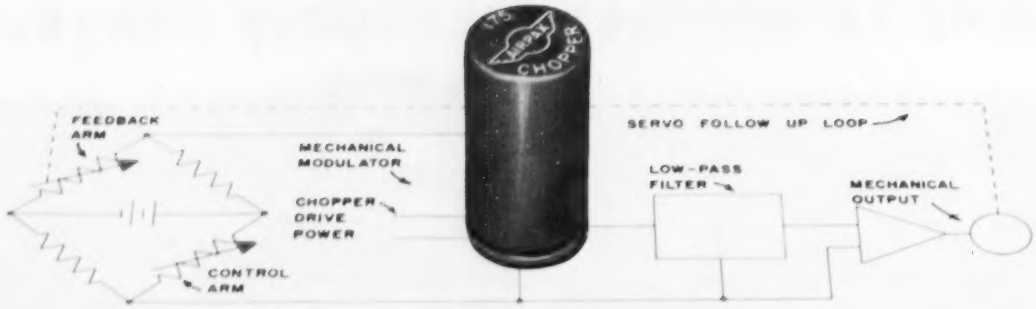
Eimac

EITEL-McCULLOUGH, INC.

SAN BRUNO • CALIFORNIA

The World's Largest Manufacturer of Transmitting Tubes

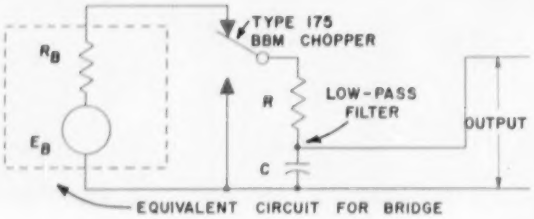
HIGH IMPEDANCE MODULATOR



To minimize loading the bridge, a high-impedance modulator is used such as Airpax Type 175

CONTROLS frequently require a modulator that presents high impedance to a bridge circuit. Perhaps you are faced by such a problem.

A typical solution is illustrated above. One arm of the bridge is used for control, the other for feedback. Output from the bridge is modulated, filtered, fed to an amplifier and used to drive a motor. The follow up to the feedback arm is phased to drive the bridge toward balance. A modulator with inherently low zero offset is essential if the bridge is to be balanced accurately.



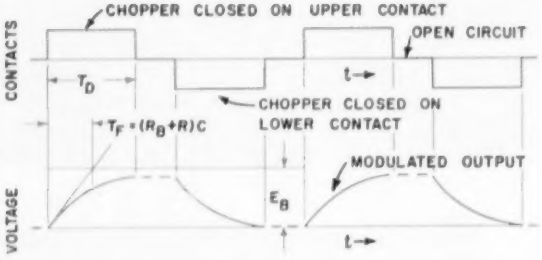
In basic modulator circuit, chopper alternately connects filter across bridge and then shorts filter

The mechanical modulator, popularly called a chopper, is ideal in this application. The break-before-make type, such as Airpax Type 175, is naturally used. (A MBB type momentarily shorts the bridge producing transients that mask the null.) The basic circuit is shown above.

A high-pass filter integrates the modulated signal to hold the output during the open-circuit interval. The action is shown in the accompanying timing diagram.

From modulation theory, we know that the circuit is insensitive to signal frequencies above half the chopper drive frequency (60 CPS for Type 175). Thus the filter is made to cut off at this limiting frequency. It also serves to narrow the noise spectrum out of the modulator.

Where an especially low noise level is required, Airpax Type 176 chopper is used. This is like Type 175 but the drive-coil leads come out the top. Another way to reduce noise is to use a variation of Type 175 with solder-lug terminals.

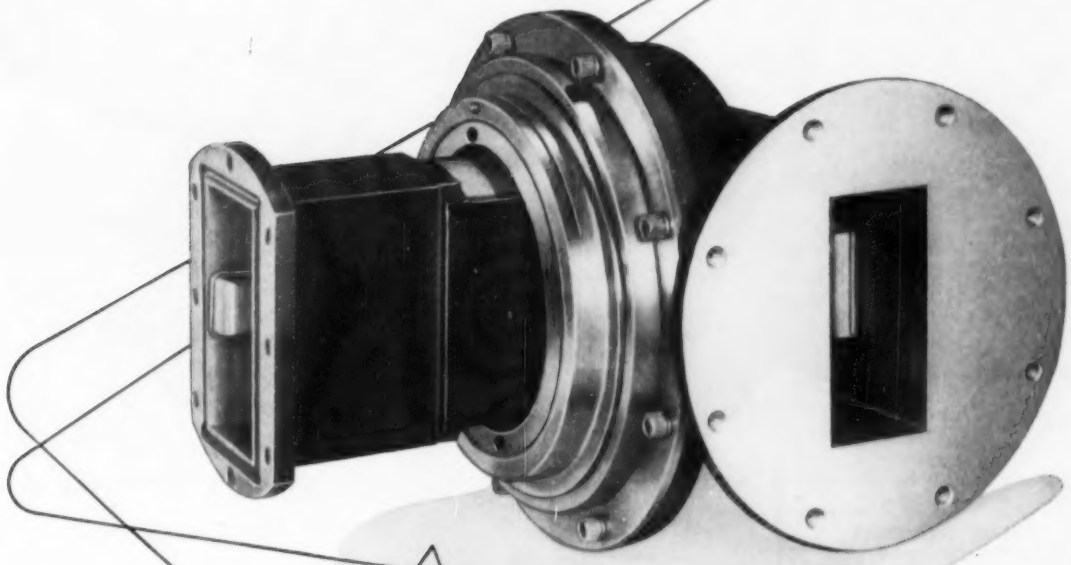


Upper diagram shows timing of chopper action, lower one shows effect of low-pass filter on output

For further recommendations on the chopper best suited to your particular requirements, write to

AIRPAX
DESIGNERS PRODUCTS COMPANY ENGINEERS
MIDDLE RIVER BALTIMORE 20, MD.

low VSWR
compact
high speed...



rotary waveguide joints by Reeves

INSTRUMENT CORPORATION

specifications

VSWR: Less than 1.10 for entire range of $f_o \pm 0.06f_o$.

PEAK POWER: (unpressurized, ¼ μsec pulse) 80 kw for K_u band; 175 kw for X band; 1500 kw for S band.

PEAK POWER: (pressurized, ¼ μsec pulse) approximately proportional to square of the absolute pressure.

HIGH ROTATIONAL SPEEDS: Center conductor supported in oilite bearing; main housing supported on ball bearing.

LOW LEAKAGE: RF chokes incorporated to prevent leakage.

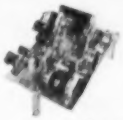
MEETS MIL SPECS: Including weatherproofing for outdoor use.

NO WOW: Coaxial design eliminates amplitude changes with rotation.

REAC Analog Computers

Precision Floated Gyros

Precision Resolvers and Phase Shifters



Servo Mechanical Parts

Compact rotary joints for either 90° or 180° orientation of input waveguide sections provide 360° continuous rotation at high speeds with broadband operation and high power handling capability. May be operated fully pressurized if desired. Standard models for K_u, X and S bands—other bands available on special order.

Write for complete details and operational data and curves.

Reeves INSTRUMENT CORPORATION

REEVES INSTRUMENT CORPORATION

A Subsidiary of Dynamics Corporation of America

201 East 91st Street, New York 28, New York

New TRANSISTORIZED MINIATURIZED

TYPE 2007T

400 CYCLES ±.02%

28 VOLTS D.C.

SPECIFICATIONS

INPUT
20 to 35V DC
at approx. 5 m.a.

OUTPUT FREQUENCY
400 or 500 cycles

Type 2007T
+ —.02% from —65° to + 85°C.

Type R2007T
+ —.002% from + 15° to + 85°C.

Type W2007T
+ —.005% from —65° to + 85°C.

OUTPUT VOLTAGE
5 volts, sine wave.

Substantially uniform
from —65° to + 85°C.

LIFE EXPECTANCY
several times that of vacuum tubes

INTERNALLY SHOCK MOUNTED
on Silastic

MAGNETICALLY SHIELDED

HERMETICALLY SEALED

OCTAL BASE

SIZE
4½" x 1½" diameter

WEIGHT
7 ounces

COMPLETE INFORMATION ON REQUEST
PLEASE SPECIFY TYPE 2007T

Precision

FREQUENCY STANDARDS

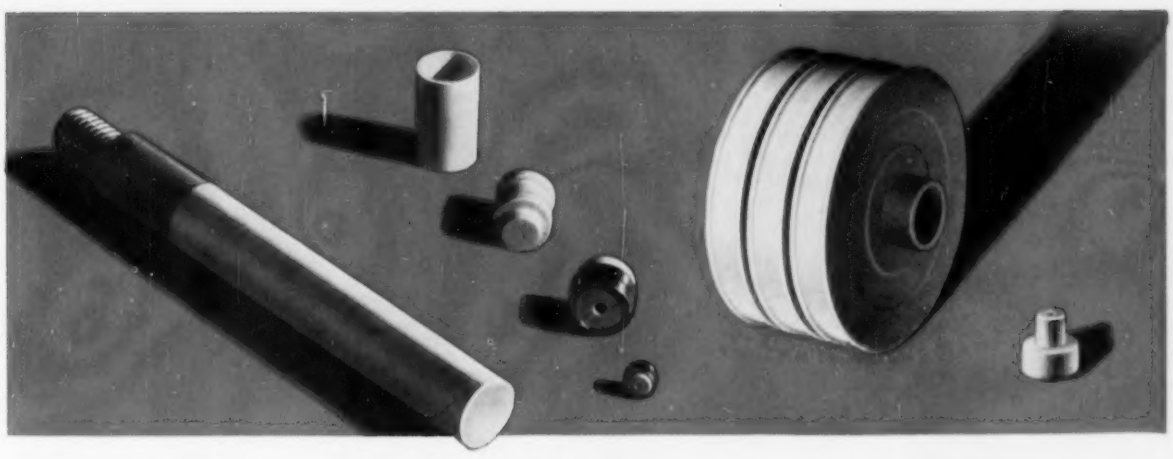
These units, which are the result of several years of development and testing, offer a new standard of simplicity and reliability. Particularly noteworthy is the uniformity of output signal voltage with temperature change. Small size and light weight make them ideal for airborne and portable use.

For applications where only higher B voltages are available, a simple voltage reducing circuit may be used.

American Time Products, Inc.

580 Fifth Avenue ***New York 36, N. Y.***

MANUFACTURING UNDER PATENTS OF WESTERN ELECTRIC COMPANY



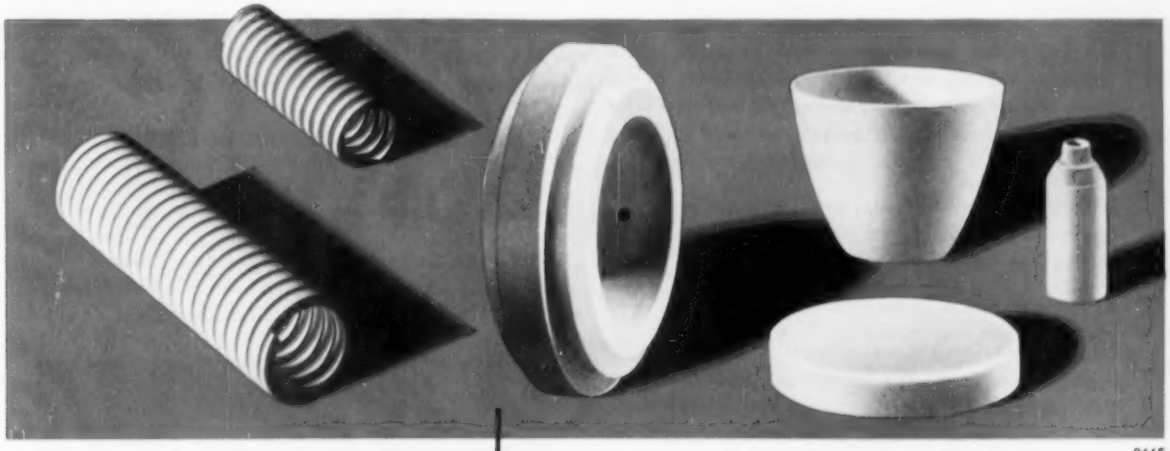
What properties of ALITE will serve you best?

- ***Its diamond-like hardness?***
- ***Its electrical resistivity?***
- ***Its high temperature characteristics?***

Alite is a sintered metallic oxide with decidedly interesting properties. It is so hard, for example, that only a diamond can scratch it. It maintains excellent dielectric properties from power frequencies throughout the entire spectrum into the super high frequency range. It retains its high mechanical strength at temperatures even beyond 2000°F. In its resistance to chemical attack it is comparable to fine quality chemical porcelain.

How is it used? In such mechanical applications as rotating seals, pump plungers, slide valves, cutting tools, sleeve bearings, bushings, extrusion dies. In electronic applications as tube envelopes, as insulating supports. It can be joined to itself or to unrelated materials with a vacuum type bond.

Certainly, any engineer concerned with material specification in mechanical, electronic, or nucleonic design problems should be thoroughly familiar with Alite and its possibilities. Bulletin A-7 tells the story. It is free on request. Write for it today.

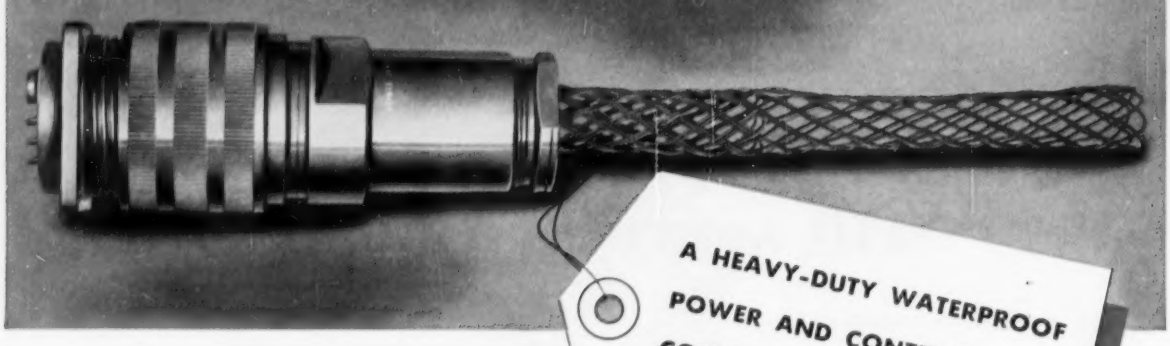


266E

Alite Divison | **U. S. STONEWARE**
AKRON 9, OHIO

Presenting the New QWL

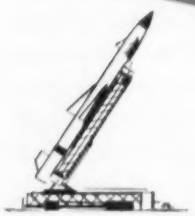
Bendix ELECTRICAL CONNECTOR



A HEAVY-DUTY WATERPROOF POWER AND CONTROL CONNECTOR FOR USE WITH MULTI-CONDUCTOR CABLE

OUTSTANDING FEATURES:

1. It combines the strength advantages of machined bar stock aluminum with the shock-resistant qualities of a resilient insert.
2. A modified, double stub thread provides for speed and convenience in mating and disconnecting and the special tapered cross-section thread design resists loosening under vibration. The threads can be easily hand cleaned if contaminated by a substance such as mud or sand.
3. An Alumilite 225 hard anodic finish is used which gives a case hardening to the aluminum surface. This finish offers outstanding resistance to corrosion and abrasion.
4. The cable-compressing gland used within the cable accessory accomplishes both a firm anchoring of the cable and effective waterproofing for multi-conductor cables. Neoprene sealing gaskets are used at every joint to insure a watertight connector assembly.
5. The cable accessory is designed to accommodate a Kellems stainless steel wire strain relief grip for additional cable locking.
6. A left-hand thread is used on the cable accessory to prevent inadvertent loosening.
7. High-grade copper alloy contacts are used which provide for high current capacity and low voltage drop. The famous Bendix closed entry socket is used for contacts sizes 12 and 16.



This new QWL Bendix* Electrical Connector was designed for and is being used principally on ground launching equipment for missiles and ground radar equipment.

Obviously for this important type of service only the highest standards of design and materials are acceptable.

That's why it will pay you to specify the Bendix QWL electrical connector for any job that requires exceptional performance over long periods of time.

*TRADEMARK

SCINTILLA DIVISION OF BENDIX
SIDNEY, NEW YORK

Export Sales and Service: Bendix International Division
205 East 42nd St., New York 17, N.Y.
Canadian Representatives: Aviation Electric Ltd.
200 Laurentien Blvd., St. Laurent, Montreal 9, Quebec

FACTORY BRANCH OFFICES:
117 E. Providencia Avenue, Burbank, California • 512 West Avenue, Jenkintown, Pennsylvania • Paterson Building, 18038 Mack Avenue, Detroit 24, Michigan • 5906 North Port Washington Road, Milwaukee 17, Wisconsin • Hulman Building, 120 W. Second Street, Dayton 2, Ohio • 8401 Cedar Springs Road, Dallas 19, Texas • Boeing Field, Seattle 8, Washington • 1704 "K" Street, N. W., Washington 6, D. C.

Bendix
SCINTILLA DIVISION

Bendix
AVIATION CORPORATION

AUTOMATIC ASSEMBLY, using the new G-E Silicon Rectifiers, is made possible by the Axial Lead design. There is no heat sink required, no troublesome screw terminals. Leads slip easily into the board, and dip-soldering quickly completes the assembly.

New General Electric Silicon Junction Rectifier operates at 150°C with full rating, delivers 250 MA at 200 V PIV—no heat sink required

New G-E Axial Lead Design And Small Package Are Specially Adaptable For Use In Automatic Circuit Assembly Equipment

More than six years of lab research and field development are behind new G-E Low Current Silicon Rectifiers. G-E engineering teams have perfected the operating characteristics of silicon for rectifiers; developed new production methods; and have proved the value of G-E Silicon Rectifiers by extensive tests.

G-E Silicon Rectifiers Offer More Advantages

General Electric Silicon Rectifiers provide a strong combination of desirable features. They operate at much higher temperatures, making possible their use in close, air-tight assemblies. Applications are much the same as for germanium units, with the exception of much higher operating ratings at temperatures up to 175° C. New Axial Lead design and small, all-welded package make it possible to use General Electric Silicon Rectifiers in automatic assembly equipment.

Reliable Characteristics

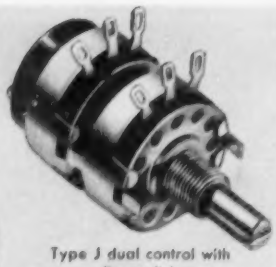
New process control techniques deliver consistently reliable characteristics. All G-E Low Current Silicon Rectifiers are protected with a full year warranty—your assurance of dependable performance.

Quantities Available Now

Sample quantities of the new G-E Silicon Rectifiers are available immediately for use in testing or development labs. See your G-E Semiconductor Specialist, or, write: *General Electric Company, Semiconductor Products, Section X446, Electronics Park, Syracuse, N. Y.*

Progress Is Our Most Important Product

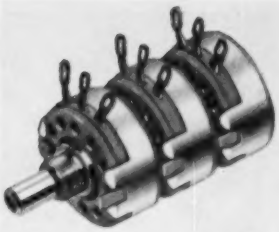
GENERAL ELECTRIC



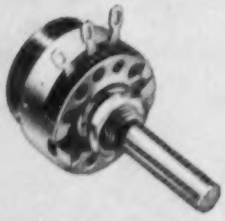
Type J dual control with line switch

Type J resistor with short shaft and lock-type bushing

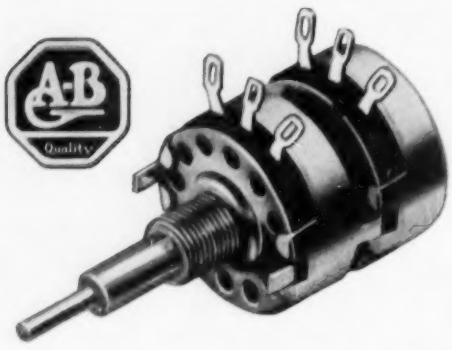
Type J single-unit resistor with plain, short shaft

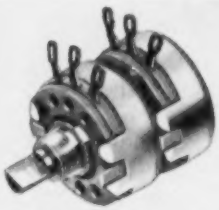


Type J triple-unit resistor

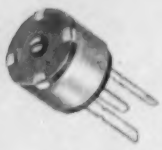


Type J single-unit with long shaft and 125v switch





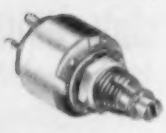
Type J dual-unit resistor with short, flatted shaft



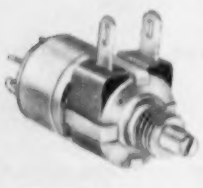
Type GP small variable resistor for printed circuits

AN "INDUSTRY STANDARD" WHERE LONG LIFE AND QUALITY PERFORMANCE ARE NECESSARY

Type J single-unit variable resistor with long shaft



Type G small variable resistors —plain or lock-type bushings



Type G small variable resistor with line switch

Here are A-B variable resistors and potentiometers that are designed for QUALITY performance. They are available in many forms and sizes.

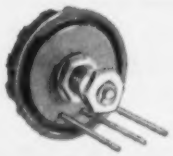
The resistor element in all units is a solid molded ring (not paint or film) supplied for standard or special tapers. The resistance material, insulation, terminals, faceplate, and bushing are molded in ONE piece. You can expect improvement with use as brush wears smoothly to flat molded resistor. There are no welded joints, no rivets, no soldered connections.

TYPE J—2 watts—in single, dual, or triple construction. With or without line switch. Dual units can be supplied with concentric shafts for individual resistor control.

TYPE G & GP—½ watt—½ inch in diameter. Type GP units have long terminals for printed circuit applications.

TYPE T—½ watt—compact units for hearing aids and similar applications.

A-B variable resistors are available in standard RETMA values up to 5 megohms.



Type T small variable resistors with hand or screw driver operated plastic covers—for hearing aids and similar applications

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS

MEMO

FROM: THE ENGINEERING STAFF AT NJE

TO: ELECTRONIC SYSTEMS ENGINEERS

SUBJECT: **HINDSIGHT...**

"Your foresight may be poor", they say, "but your hindsight is always 20-20."

Maybe so, but there are days when our hindsight is pretty dim. Take the age-old standard-versus-custom argument, for example.

As everyone knows by now (we grow hoarse repeating it) we offer by far the longest, most diversified list of catalog power supplies in the industry—over 500 models, and hundreds of "quickie" stock variations.

Every month, in addition, we design and build about $100,000 worth of custom power supplies . . . and every time we complete one, we add it to our list, hoping to sell it again, minus the design fee.

When the same custom design has been sold to a number of different people, we begin to worry . . . does it belong in the regular catalog? Maybe not, but we're going to try a compromise:

We've selected about 200 of the most-frequently-requested custom supplies, and prepared a Custom-Design File, which we'd like to send you. Here are a few samples:

200-2000	0-200 ma	1 volt	1% line, or load	Series-tube reg.	CS-2308	$1200.00
0-350	0-3 amp.	10 mv	0.25% L or L (or 0.08 volts)	"	CS-3443	1200.00
200-400	0-1.5 amp.	.15%	±2% (±1.5% at 400V)	Brute-force Germanium (Tubeless)	CS-4091	600.00
0-1500	0-200 ma	.1%	0.5% line or load	Series-tube reg.	CS-3361	900.00
250-300	0-1 amp.	10 mv	0.3% line or load	"	CS-4625	400.00

Incidentally, delivery is excellent—5 to 6 weeks, usually. Minor variations in range, performance, packaging, etc., are cheerfully done at nominal additional charge.

For our complete line of electronic power supplies See electronics BUYERS' GUIDE Pp. 113-120

NJE corporation

Electronic Development & Manufacturing

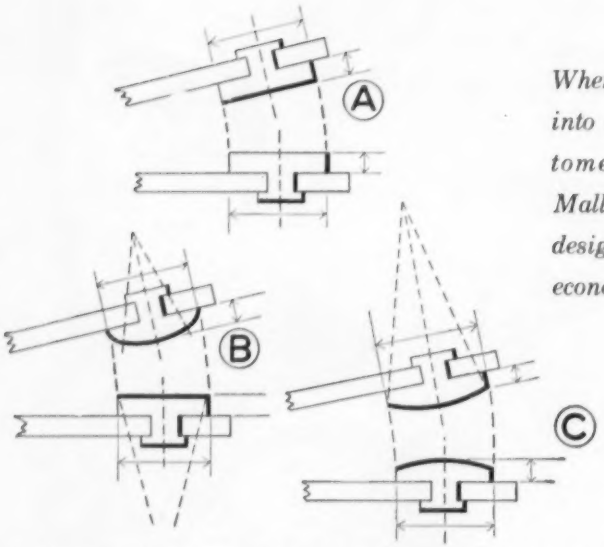
Write today for your copy of our Custom-Design File.

145 CARNEGIE AVENUE, KENILWORTH, NEW JERSEY

Competent Engineering Representation Everywhere | Rapid, complete, competitive custom quotes from 1000 Amperes (low voltage) to 250 KV (low current.)

POWER SUPPLIES UNLIMITED

MALLORY



When Original Design A ran into alignment trouble, the customer proposed design B. Mallory engineers recommended design C as the most efficient and economical solution.

How economical are *your* contact designs?

Mallory Contact Engineering Offers Five Ways To Improve Economy

1. **The most effective contact material** from the extensive line developed by Mallory. More economical alloys often can satisfy *actual* service conditions.
2. **The most economical contact design** . . . for your purchasing, production and product needs.
3. **The most economical backing material** . . . from a group of Mallory alloys developed for this use.
4. **The most economical backing member design** . . . in relation to contact and product design requirements.
5. **The most economical method of assembly** of contact and backing member.

By coordinating *all* these important elements of contact design, Mallory can help you put into effect a long-range plan for cutting contact cost and assuring peak performance.

DESIGN of electrical contacts is an engineering job in which Mallory's specialized experience can often lead to substantial savings for you. A case in point—a manufacturer of circuit breakers wanted to use a combination of flat and radius-faced contacts to lick an alignment problem in production. This design required buying and stocking of two separate contact parts.

Mallory contact engineers came up with a money-saving improvement. They recommended a modified radius design to go on both the stationary and moving contacts. Substantial production time was saved by elimination of the alignment difficulty in assembly. In addition, by buying a *single* type of contact engineered for the job, instead of two separate designs, the manufacturer cut his inventory problem in half, simplified purchasing and handling, and saved a significant percentage of direct contact cost as well.

There's a good chance that you can realize comparable savings on your own contact applications, by bringing your problems to Mallory specialists. The complete engineering job that our staff can undertake will assure you of gaining the maximum in performance . . . at the peak of economy . . . for your specific requirements. For a consultation, write or call Mallory today.

Expect more . . . get more from

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

electronics

W. W. MacDONALD, Editor

APRIL • 1956

CROSS TALK

▶**TRAVELOG . . .** This is written in Los Angeles, half way through a field trip, in response to a gentle yet insistent wire from New York re deadlines.

Chicago (cold), Cedar Rapids (colder), Denver (still colder, plus snow), San Francisco (wet) and now southern California (cool air, hot sun). Soon Phoenix (?), Dallas (?) and back home to the east, where we hope the weather is better than when we left.

▶**HI-FI HELP WANTED . . .** Most frequent topic of conversation out this way is the continuing search for more engineers.

Apparently most of the young men who could be readily enticed to move west for, among other things, the salubrious climate, have already emulated Horace Greeley. Now many manufacturers who have successfully sold the sun are losing talent to new plants in still sunnier locations.

We met a man just the other day who is altering the layout of a building already under construction to provide plushier quarters for engineering. Another is advertising for engineers over a local hi-fi broadcasting station, hoping perhaps that there may be some affinity between lovers of Bach and Bessel Functions.

▶**DISTRIBUTION DILEMMA . . .** Right across the country, manufacturers have expressed some concern about the current difficulty of obtaining good sales representatives for their lines, particularly in the instrument business.

It seems that some of the larger companies, in the interest of diversification, have started to produce items with which they have not previously been concerned. These new items are frequently competitive with similar products handled by their reps but made by other companies. So something has to give.

Caught in this nutcracker, newer and smaller manufacturers who have not yet built up nationwide distribution are feeling the pinch.

▶**TALENT BANK . . .** For obvious reasons, we have been sounding out people anent patents, and can report that while there is some satisfaction about the government's interest in preserving a free economy this satisfaction is indeed mild.

More often, men we have talked to have wondered out loud if the price that has been paid for what might be considered centralized banks of research talent hasn't been quite moderate. How are these talent banks to be supported? Will small companies pick up the load if they cannot be supported?

Thinking is generally along these lines.

LOOKING AHEAD . . .

Modified polyethylene subjected to high-energy nuclear radiation during production retains its excellent insulating characteristics at 150 degrees centigrade. Wire using such insulation is expected on the market within a month

Amateur single-sideband enthusiasts will have plenty of commercial company from now on. Design of much point-to-point communications equipment for use above 30 mc is headed in that direction

Electrical radiation from some two-hundred discrete points in the heavens has been charted in Britain, in Australia and in the United States. These signals can be the basis for new systems of navigation

Relatively noise-free high-frequency amplification can be obtained with traveling-wave tubes. It may not always be necessary to heterodyne to get receiver gain

New Applications For

SUMMARY — Ten-target magnetron switching tube, now in commercial production, combines accurate visual read-out with high-speed electronic reset. Circuits given here show its versatility as a regular or variscale counter, multiplexer, distributor or gate

By JOHN BETHKE

Applications Engineering Department
Haydu Brothers of New Jersey
Plainfield, New Jersey
Subsidiary of Burroughs Corp.

A BEAM SWITCHING TUBE contains ten identical arrays of spades, targets and grids symmetrically located around a central oxide-coated cathode as in Fig. 1. The spades form and sustain the electron beam, the targets produce a functional pentode-like output and the grids switch the beam from array to array.

Normally, when the tube is turned on by applying B+ voltages after a suitable filament warmup time, the tube will remain in its clear state and there will be no beam formed. This corresponds to the cut-off condition of a split-anode magnetron.

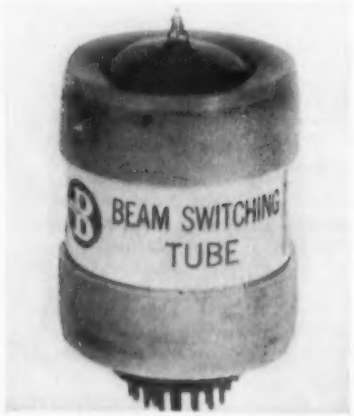
With the tube initially in this cut-off or cleared condition, the static voltage-current characteristic of an individual spade is represented by curve 1 of Fig. 2.

The dynamic spade characteristic, represented by curve 2, is obtained with the lagging spade at 0 or cathode potential, simulating the condition that exists during switching. Actually, the dynamic curve decays to the static curve after the switching transition as the lagging spade's voltage recovers at a rate determined by its R-C time constant.

These curves, taken with all the other electrodes at 100 v, can be used to determine the values of spade load resistors that will provide bistable operation for each spade. Load line R_H for a 60,000-ohm resistor indicates the lower limit, whereas R_H for a 500,000-ohm resistor indicates the upper limit.

A smaller resistor than 60,000 ohms would create a load line that would not intersect the static curve and hence there would be only one stable point, at a; this means that the beam could not be formed. A resistor larger than 500,000 ohms would form a load line that would intersect the dynamic curve only at d, which is the lower state. This implies that as each spade in turn is the leading spade, the beam will automatically be formed to this position, causing astable operation or continuous switching of the beam at a frequency determined by the spade current and the R-C time constant associated with each spade.

Load line R_L, for a 100,000-ohm spade resistor, intersects the characteristic at points a, b and c. Intersection a corresponds to the tube in the cut-off condition, with no beam formed; point b is unstable; intersection c represents the second stable state with a beam formed. The beam may be formed from the cleared condition to any one of the tube's ten positions by



Tube is 3 inches long including polyethylene end caps. 1.7 inches in diameter and weighs 5 oz including its encapsulating cylindrical permanent magnet

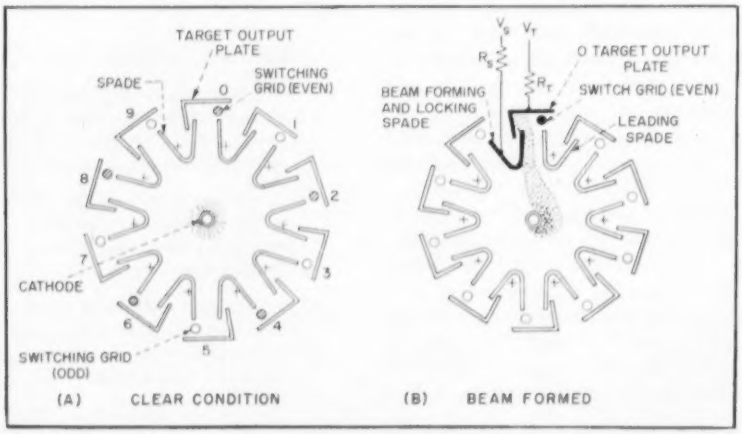


FIG. 1—Electron beam in 450-gauss axial magnetic field serves as equivalent of contact arm in switching from one to another of the ten target output plates under control of spade and grid potentials. Tube designation is now type 6700 (formerly type MO-10)

Beam Switching Tubes

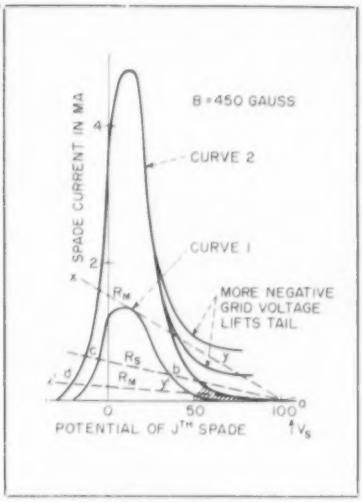


FIG. 2—Spade characteristic curves

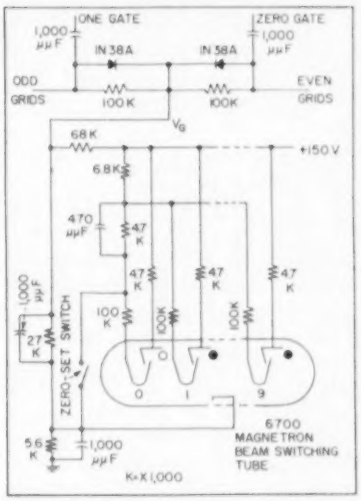


FIG. 3—Basic switching circuit

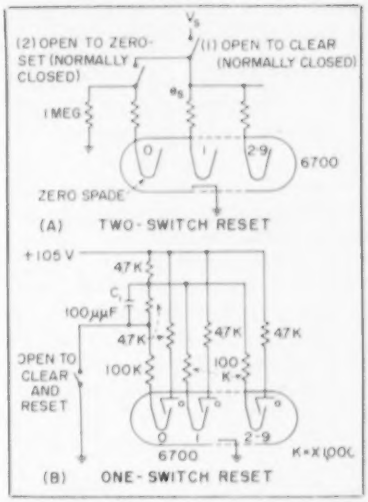


FIG. 4—Resetting circuit arrangements

lowering the potential of the respective spade from point *a* to where the negative charactertistic will take over and lock the beam in at point *c*.

The general shape of the electron beam with it holding on a spade is shown in Fig. 1B. The spade B+ is instrumental in controlling the magnitude of cathode current and hence the spade and target currents. The normal range of spade voltage with 100,000 ohm spade load resistors is 90 to 110 v, producing 4 to 8 ma of target current respectively. The targets are essentially pentode-like in that they receive a constant current within a target voltage range of from $\frac{1}{2}$ V_s to the maximum target voltage rating. Pulses up to 1,500 v at frequencies above 150 kc have been obtained experimentally. The grids are effective switching electrodes, taking little or no current and hence representing high-impedance inputs.

Switching Action

The beam may remain holding indefinitely as in Fig. 1B or it may be advanced sequentially or reformed to any other position at 1-microsecond rates as will be discussed later. The shape of the dynamic or leading spade's characteristic is altered by varying the potential of the switching grids. Making the grids more negative raises the right-hand portion of the dynamic characteristic so that load line R_s has only one intersection, at point *c* which is the *on* state.

If the grids are connected in parallel a quantized input pulse is required to insure single-step sequential switching, due to the fact that the switching time is in the order of 0.1 microsecond. The spades can be padded with additional capacitance, as determined by the maximum scaling frequency, to reduce the stringency of the input pulse requirements. Actually, the grids are internally connected in groups of five and the external connections are termed even grids and odd grids. The even grids are associated with the even spades and serve to switch the beam from an even position to an odd position. With the grids so connected, they can accept pulses as supplied by a flip-flop or they can be driven from a push-pull sine-wave source

The beam switching tube circuit shown in Fig. 3 is basic enough to introduce the tube and yet versatile enough to have many applications with few modifications. The modifications to meet the requirements of the particular application may be in the type of input drive used, the method of zero setting or the type of target load. The circuit has a degeneration resistor in the cathode circuit and a bleeder network to obtain the grid bias, both of which serve to insure reliable operation with wide B+ tolerances. The input signal, whether in the push-pull form shown or a single discrete pulse, should be of sufficient amplitude to vary the grids from their bias of approximately +25 volts to −20 volts with respect to the cathode.

Zero Setting

When B+ is first applied, the tube remains in its cleared state and no beam is formed. The beam may be formed to any position from this cleared condition by lowering the potential of the respective spade to where the negative spade characteristic will take over and form and lock the beam. This method, which can be accomplished with a spst switch, functions well when the tube is being zero-set from the clear or cut-off condition. However, once the beam is formed, depressing such a zero-set switch will not always return the beam to the zero position.

This is explained as follows: The beam, holding in the zero position, can be formed to a leading position (1 through 4) merely by lowering the potential of the respective

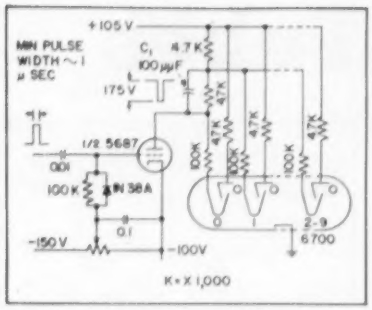


FIG. 5—High-speed clear and reset circuit using direct coupling

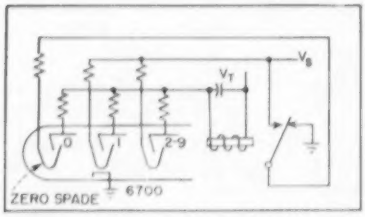


FIG. 6—Automatic zero reset circuit

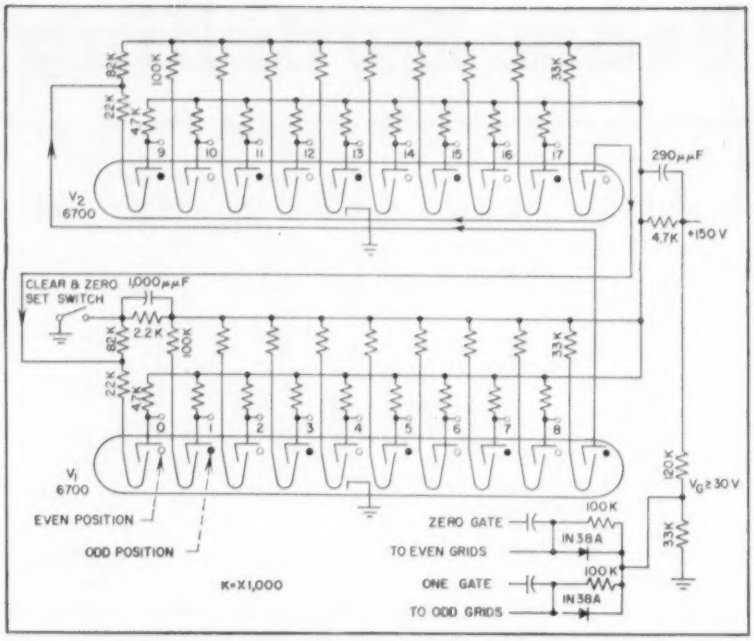


FIG. 7—Multiposition distributor using two type 6700 magnetron beam switching tubes

spade, whereas lowering the potential of a lagging spade (6 through 9) will not shift the beam from the zero position. Spade 5 is a borderline position and its influence will be determined by the magnitude of the spade supply voltage. Thus, the beam cannot be reset to zero from every position merely by lowering the voltage of the zero spade.

One way to circumvent this phenomenon is to clear the tube before resetting. This clearing can be accomplished by momentarily removing B+ or by lowering the spade-cathode potential to a voltage that will not sustain beam formation. Figure 4A illustrates the use of two spst switches, for clearing and zero setting respectively. Switch 1 in this circuit is normally closed and serves to interrupt B+ for clearing the tube.

Simplified Zero Setting

Figure 4B indicates how one spst switch can accomplish simultaneous clearing and zero-setting. Depressing the normally open switch reduces the spade potential sufficiently to extinguish the beam. When the switch is released, the common spade bus begins to recover to B+. Since the 0 spade has been lowered beyond the others and is slowed in its recovery by C_1, it follows that when the common spade connection reaches a potential that will form and sustain the beam, the lower voltage of the 0 spade will form the beam to this position.

Electronic Zero Setting

The circuit of Fig. 5 allows the beam switching tube to be reset with a pulse of approximately 1 microsecond duration. The resetting pulse, applied to the grid of a normally cut-off triode, triggers this tube on, allowing the plate current to flow through the two 4,700-ohm resistors to B+. The spade bus is thus lowered, which suffices to clear the tube. At the termination of the pulse, when the voltages begin to recover to B+, the 0 spade voltage recovery is retarded by C_1. Thus, when the spade bus recovers, the beam will form to the spade with the low potential.

The targets are returned directly to B+. This is done to prevent pulses from appearing on all targets when resetting. This method of resetting can be used in a variscale distributor, as will be discussed later.

Certain applications call for an automatic zero set. Figure 6 shows how a relay may be used to reset the tube. The 0 spade is held at cathode potential by normally closed contacts. When the beam is formed, the target current energizes the relay which serves to open these contacts, permitting normal operation of the tube. If B+ should be interrupted for any reason, the beam will automatically be reformed to the 0 position when B+ is again applied.

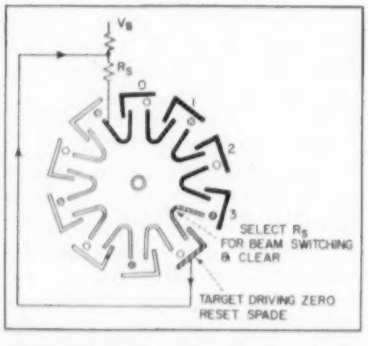


FIG. 8—Tube interconnection for four-position indication

Nondecimal Counting

Certain applications call for scalers of other than ten counts having a functional output at each position. As previously mentioned, the beam need not be advanced sequentially, but rather may be formed

from any position to any other position either within the same tube or between separate tubes. One way to accomplish this is to select a spade load line large enough to produce switching using the dynamic curve in Fig. 2, but not large enough to sustain the beam using the static characteristic.

One example of this type of switching is shown in Fig. 7, a schematic for a multiposition distributor. In this circuit, only one beam switching tube is *on*, the other or others being in the cleared state. The switching pulses applied to all tubes in parallel cause the beam to advance in V_1 from position 0 to position 8 in the normal manner. When the beam is switched to position 9, two simultaneous actions occur. Target-9 current of V_1 lowers the 0 spade voltage of V_2, thus forming the beam on the 0 position of V_2 which is the overall 9th position. Further, the 9 spade resistor of V_1 is of such a value that this tube clears itself. When the beam reaches a corresponding section of V_2 the action is repeated and can be used to initiate a third tube or reset V_1. A distributor of $9N$ positions (N being the number of tubes) is thus obtained with no reduction of scaling frequencies and using the B+ power requirements of only one tube. Figure 8 employs the same technique within a single tube to obtain less than 10 positions.

The high-speed clear and reset

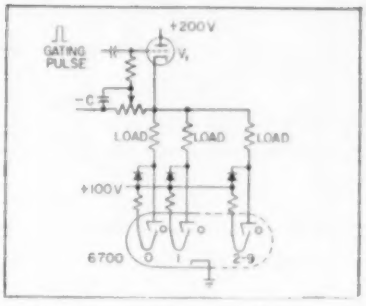


FIG. 9—Single-triode gating circuit

circuit shown in Fig. 4B is another method of obtaining a count of less than 10 that lends itself to a variscale application. The variscale is a counter-distributor capable of having its count varied from 2 to 10 positions. In this operation, a pulse is taken from the Nth position to trigger the high-speed clear and reset circuit which in turn resets the beam to the 0 spade.

Some applications call for the tube to scale in its normal manner with no beam apparent, that is, without having the beam current reach the load associated with each target until a gating pulse is applied. The technique of using a single triode to obtain this gating function is shown in Fig. 9. Each target is returned to the spade B+ of approximately 100 v through a diode.

With gating tube V_1 normally biased beyond cutoff, these diodes provide the path for the target current. Under this condition, the loads are void of any target current; however, when V_1 is gated on by the application of a positive signal, current flows through the load associated with the target on which the beam of the switching tube is impinging.

Transfer-Storage Circuit

In the transfer-storage circuit of Fig. 10, V_3 and V_4 are normally biased beyond cutoff. Switching tube V_3 is in its cutoff or cleared state and V_4 is made to scale or count in its normal manner. Under the above conditions the target current of V_3 flows through diodes D_1 to the higher B+ of 300 v and the 20,000 ohm load resistors are void of any switching tube or leakage currents. The positive transfer pulse gates on tube V_3, causing its plate current of approximately 25 ma to flow through the 8,000-ohm resistor; this lowers the potential at the junction of the V_3 plate, the 8,000-ohm load resistor and diodes D_1 to approximately 100 v. With this lowered voltage the target current of V_3 will now flow through diodes D_2. This target current will also pass through the 20,000-ohm resistor associated with the holding target, developing a voltage drop of approximately 100 v that is coupled to the corresponding spade of V_4.

Storage switching tube V_4 can be connected to remember the position of the beam in V_3 at the initiation of the transfer pulse, or V_4 can be connected to follow the count of V_3 for the duration of the transfer pulse and remember the position of the beam at the termination of the transfer pulse. The latter method can be accomplished by connecting targets 0, 1, 2 etc of V_3 to spades

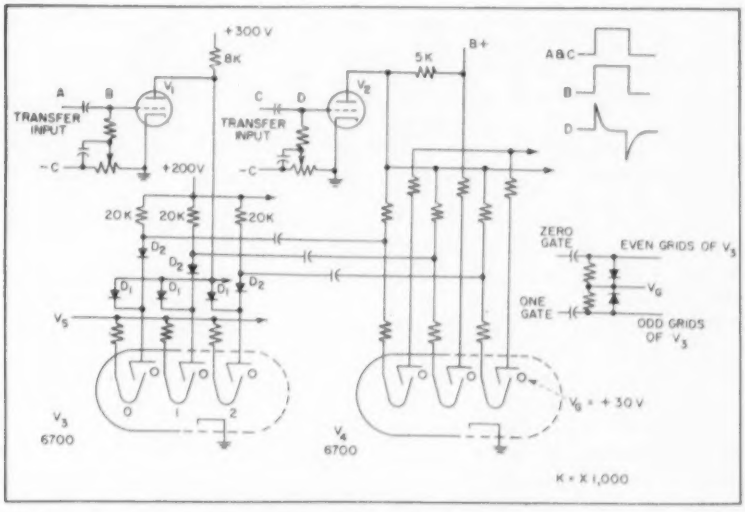


FIG. 10—Transfer-storage circuit using two switching tubes

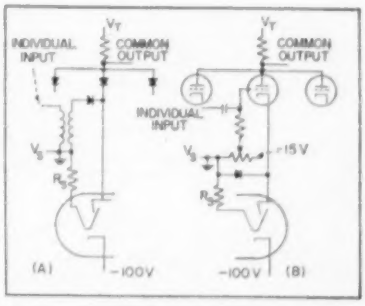


FIG. 11—Beam-gated sampling circuits

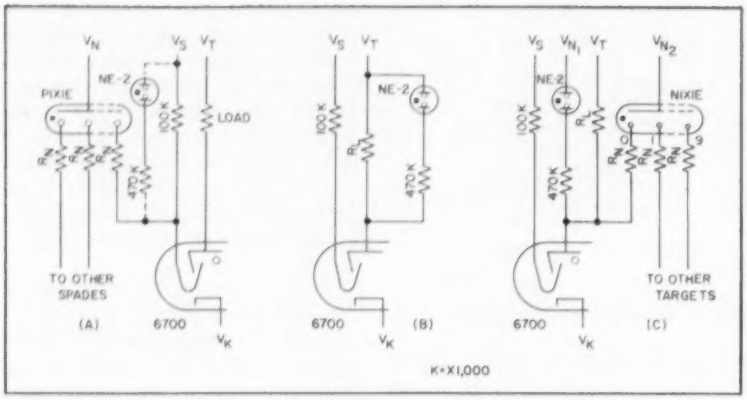


FIG. 12—Three methods of obtaining visual read-out

0, 1, 2 etc of V_4 respectively. With V_4 connected in reverse order, so that targets 0, 1, 2 etc of V_3 are connected to spades 9, 8, 7 etc of V_4 respectively, V_4 will remain locked in on the first position even though the transfer pulse should remain on for as many as four counts of V_3. This is accomplished because of the inherent ability of the switching tube not to step backwards.

At the termination of the transfer pulse V_3 will continue to scale whereas V_4 will remain holding on the transferred position. The next transfer pulse serves to clear V_4 by gating on V_2 for a shorter time than the duration of the transfer pulse (by differentiating the transfer pulse in the grid circuit of V_2), thus making it possible to store to any position of V_4 including a lagging position.

Multiplexing Circuit

A low-impedance beam-gated sampling circuit using crystal diodes is shown in Fig. 11A.

A triode gate similar to that used in the Beamplexer multiplexing unit, currently manufactured by Burroughs, is given in Fig. 11B. One use of the instrument is as an electronic switch for a single-channel oscilloscope. The technique can also be used as a parallel to serial converter taking many parallel inputs and sequentially gating them to a common load resistor.

Various methods are available for obtaining visual read-out. The functional pentode-like output of each position within the new switching tube again comes to the foreground as an advantage over conventional tubes, transistors or magnetic core counters.

Figure 12A shows the use of either NE-2's or the Haydu position indicator (Pixie) in the spade circuit, providing a visual indication without altering the versatility of the target output. The Pixie 10-position low-power, low-cost indicating device has a single plug-in envelope fitting a standard socket. The addition of the indicating device in the spade circuit has the disadvantage of adding capacitance to the spade, which reduces the maximum operating frequency of the switching tube.

The two above-mentioned indicating devices, as well as the National Union Inditron and the Haydu Nixie, can also be included in the target circuitry. In Fig. 12B the target supply voltage must be sufficiently high to prevent the ON target voltage from becoming lower than half the spade supply voltage, since the entire ionization voltage is developed across target R_L.

In Fig. 12C the NE-2 neons, the Nixie or the Pixie can be prebiased with a separate power supply and a pulse developed across R_L to vary the voltage across the indicating device from below sustaining to above ionization voltage. The same precaution of preventing the ON target voltage from becoming less than $\frac{1}{2}$ V_s must be observed.

The Nixie numerical indicator has low current, long life, small size and little parallax, and provides a visual read-out directly in numerical form.

Low-Voltage Version of Tube

A new low-voltage version of the switching tube, currently available as a production prototype, is capable of 1-mc operation and will supply 1 ma of target current with a B+ of 24 v. Figure 13 shows a transistorized flip-flop driving this new beam switching tube with a single 22.5-v battery supplying the B+ power. The advantages of this tube are: (1) Low voltage and low power that makes the tube compatible with transistors; (2) output currents of sufficient magnitude to operate relays directly; (3) improved switching requirements.

Reducing the magnetic field from 450 gauss to approximately 160 gauss produces more uniform switching around the periphery of the tube so that 20-v pulses provide reliable operation.

This new beam switching tube is proving its versatility in pulse counting, frequency dividing, distributing, multiplexing, gating, matrixing, coding and timing as an integral part of communications equipment and other data-handling devices such as telemetering, fire control, radar, loran and automatic control.

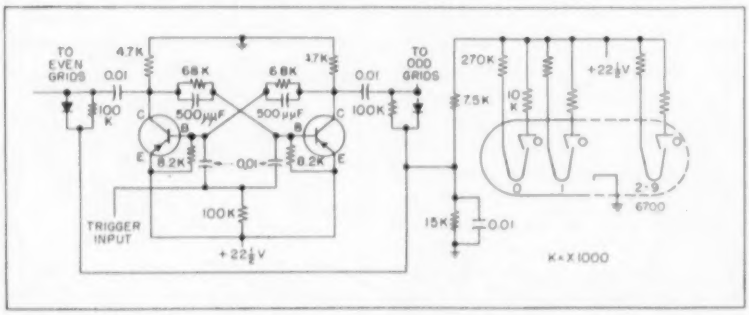


FIG. 13—Transistor driver used with low-voltage version of beam switching tube. One switching tube can do all the functions of approximately twenty transistors

VIBRATION METER Uses Transistors

By JOHN F. KINKEL and M. CARR WILSON

Consolidated Electrodynamics Corp., Pasadena, California

SUMMARY — Instrument that measures vibration frequencies from 5 to 1,000 cps can be used in the field conveniently without power-line connection. Transistors are immune to vibration effects that might cause microphonics in tubes. Biasing circuit compensates for fluctuations over temperature range —20 to 120 F

VIBRATION MEASUREMENTS must frequently be made where portability is desirable and power not readily available. The transistor vibration meter to be described satisfies these requirements. Operated with conventional vibration pickups, it indicates peak-to-peak linear and torsional vibratory displacements. It can be adapted to velocity and frequency analysis of vibration by auxiliary equipment.

Engineer uses transistor vibration meter to check performance of grinding machine

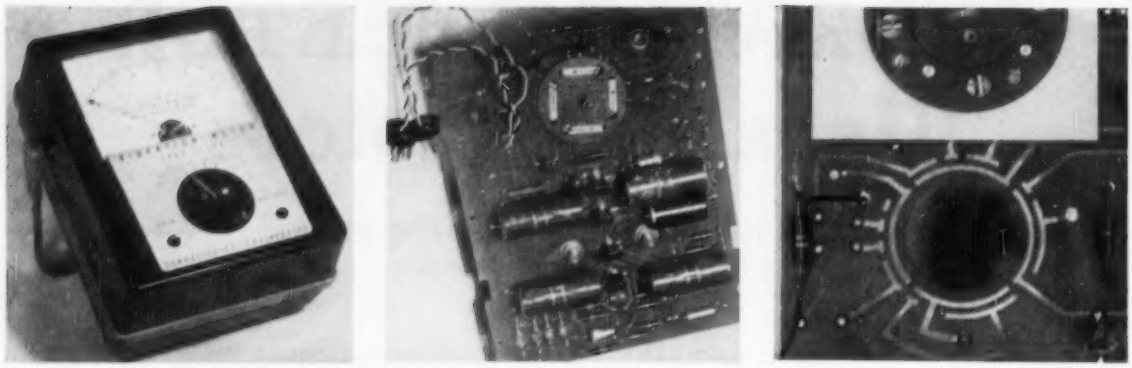
Vibration in machine tools can substantially reduce tool life and adversely affect quality. Vibrations of only 0.00006 in. amplitude in a grinding machine can produce marked degradation in the quality of a ground surface.[1,2] The shift from propeller-driven to jet aircraft has produced a significant vibration problem. Important vibrations in reciprocating-engine, propeller-driven aircraft are low frequency and large amplitude. They are readily detected and evaluated by the pilot or flight engineer. Vibrations in turbine and jet aircraft are high frequency, small amplitude and can reach dangerous levels before being recognized.[3]

Design Requirements

Portability of vibration-measuring equipment is important in preflight jet-engine runups, machine-shop operation and mobile testing. Ambient temperatures are expected to range from —20 to 120 F.

The environment can be expected to have fairly high sound levels and microphonic elements cannot be tolerated. The use of transistors avoided the problem of microphonics and also eliminated the need for long warmup periods.

Vibrations in the range of 5 to



Front panel of vibration meter having six-position frequency range switch, one side of double-etched circuit board and front and rear closeup views of etched range switch

1,000 cycles are conveniently detected with self-generating electromagnetic transducers. These transducers consist of a permanent magnet and a moving coil arranged such that motion between the transducer case and an internal seismic mass causes the magnet to induce a voltage across the coil. A typical vibration transducer is shown in Fig. 1A. The induced voltage across the coil is directly proportional to displacement and inversely proportional to the period of displacement. It is a velocity signal having the characteristics shown in Fig. 1B. If this pickup voltage is applied to an integrating circuit or integrating amplifier having the characteristics shown, ideally the output frequency plot will be as indicated. This integrated velocity signal is a voltage proportional to displacement.

Separation and analysis of frequency components of vibration can be accomplished by filters of known characteristics between the pickup and the integrator. Use of high-pass or band-pass filters eliminates unwanted portions of the vibration spectrum under study. For example, it is necessary to determine separately propeller vibration and turbine vibration in turboprop engines. Since these are separated in frequency by approximately a decade, band-pass filters permit ready identification and measurement.

Vibration Meter

A schematic of the vibration meter is shown in Fig. 2. The instrument consists of a constant-impedance resistive attenuator, followed by a two-stage integrating amplifier. The integrated output is further amplified and applied to the bridge detector. Bridge current is read on a 500-microampere meter. All power is supplied by two 22½-v batteries.

The integrating amplifier consists of two junction transistors TR_1 and TR_2. The input stage employs the common-emitter connection, while the second stage uses the common-collector mode. Feedback around these two stages provides integration to produce a displacement output. The low-frequency gain characteristic is shown in Fig. 3.

A particular feature of the circuit is its ability to increase overall displacement-signal sensitivity by sacrificing the low-frequency response of the integrator. Figure 3 shows two gain characteristics displaced by one frequency decade. These characteristics are obtained by switching the 1 and 0.1-μf range capacitors. This results in a 10-to-1 change of displacement voltage for a given velocity signal and provides an effective ten-fold increase in sensitivity without additional amplifier gain.

Performance

Design-center maximum sensitivity is approximately 35 microvolts rms for full-scale meter deflection, which corresponds to 0.5 ma peak-to-peak displacement. At this level, signal-to-noise ratio is significant and care must be taken in selecting the input transistor. Variation in noise output with temperature is appreciable for some types of transistors; the maximum noise figure allowable in 1-cps bandwidth at 1,000 cps has been established as 15 db. The noise is predominantly flicker noise.

Meter Amplifier

The meter amplifier uses transistors TR_3 and TR_4 both connected in the common-emitter mode. Feedback around these two stages, including the bridge rectifier, assures a meter deflection proportional to the average input. The deflection is essentially independent of the

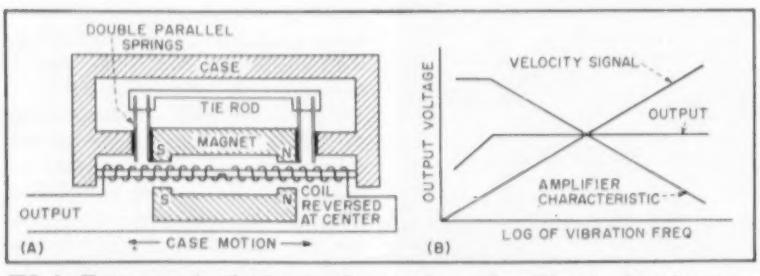


FIG. 1—Electromagnetic vibration transducer used as pickup (A) and voltage-frequency transfer characteristics of system (B)

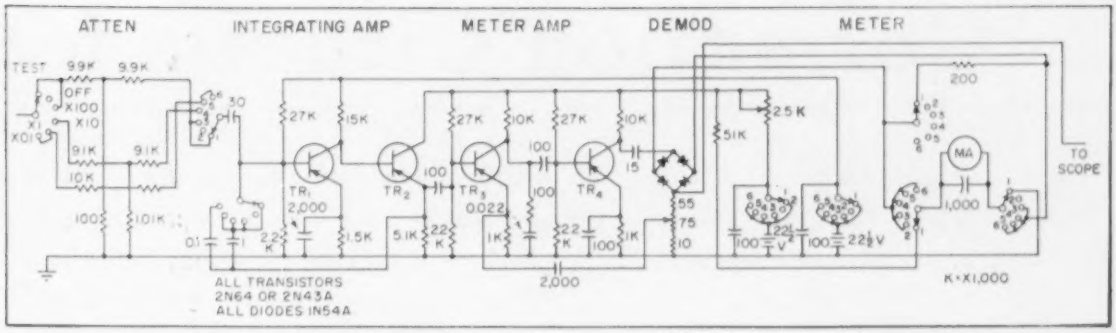


FIG. 2—Integrating amplifier uses one grounded-emitter and one grounded-collector stage. Meter amplifier uses two grounded-emitter stages. Range switch controls input attenuator

diode forward-current characteristics for normal small diode back-current values. Feedback voltage appears across the 75-ohm potentiometer in the output of TR_4. The potentiometer acts as a gain control.

The fourth-stage output is available at a jack and can be observed with an oscilloscope or a recorder having an input impedance in excess of 10,000 ohms.

The overall frequency response referred to 100 cps is given in Table I. A significant factor in frequency performance is the temperature sensitivity of the electrolytic bypass capacitors. Increase in internal series resistance at low temperatures increases degeneration in stages 1, 3 and 4.

Another significant temperature effect is the variation in collector current cutoff I_{co} of the transistors. The biasing networks have been designed to stabilize the circuit against variations in this parameter over the temperature range.

Current drain from the two batteries differs in a ratio of roughly 3 to 1. Hence the internal resistance of one will increase more rapidly than the other. The voltage of the battery having the greater drain is checked by the test-battery circuit and is adjusted by the 2,500-ohm resistor. Since the useful voltage to the predetermined endpoint of 15 v is governed by internal resistance, the batteries can be interchanged once to obtain greater useful life from both.

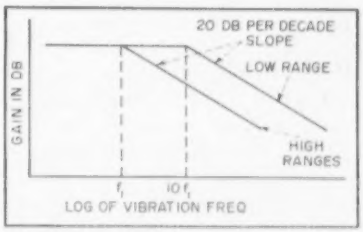


FIG. 3—Frequency response of meter on low and high frequency ranges

Design Features

The circuit lends itself to etched wiring. However, the geometry required for instrument compactness and the size of the special low-temperature capacitors require a two-sided etched board. All mounting and through connections on the board are eyeletted. The use of a two-sided board and the sensitivity of several components to soldering temperatures precluded dip-soldering. All heat-sensitive components are soldered using heat-sink pliers as a precaution.

All electronic components, including the meter, are mounted on the etched board, which is in turn assembled on the upper half of the die-cast case. Connection to the input and output jacks is by solderless sleeve-and-pin elements.

The two-sided etched board permits use of an etched equivalent to a conventional eight-pole six-position wafer switch. A detail of four poles is shown in a photograph. Switch elements and wipers are gold-plated. Switching is accomplished by wipers which short the inner races to the desired outer contacts. By proper orientation of the switch circuits on opposite sides of the board, it was possible to make both wiper disks identical.

The selector-switch knob and the indexing mechanism are integral with the case. The mechanical driving connection between the knob and wiper disks is a flatted bar which slides into the slot in the wiper disks. The indexing mechanism has a spring return action in the test-battery position, returning the switch to OFF upon release to reduce battery drain.

The carrying handle can be pivoted to form a supporting stand holding the instrument at 30 deg.

The authors acknowledge the contributions of R. L. Sink and Norton W. Bell for origination and development of the instrument and F. Walsh for styling and design.

Table I—Overall Frequency Response

Range	Frequency in cps	Tolerance in percent	Temperature in deg F
×0.1	50–1,000	± 5	−20 to +120
×1, ×10, ×100	10–1,000	± 5	0 to +120
×1, ×10, ×100	20–1,000	± 5	−20 to +120
×1, ×10, ×100	10–1,000	±10	−20 to +120

REFERENCES

(1) W. D. Nesbit, Vibration Testing Increases Tool Efficiency, *Iron Age*, Dec. 23, 1954.

(2) Consolidated Electrodynamics Corp., Machine Tools and Vibration, Bulletin 1355.

(3) A. F. Gebhart, Aircraft Monitoring Systems for Vibration Monitoring in Flight, Consolidated Electrodynamics Corp., TP23, Aug. 1955.

Correction Circuits for

SUMMARY —— Gamma and matrix correction circuits offset restricted brightness ranges of color cameras for live and film pickups, giving more pleasing color reproduction despite brightness range that may be as high as 180 to 1 in normal theater color film. Matrix amplifier corrects for hue shift and loss of saturation caused by gamma overcorrection

IN TRANSMISSION and reproduction of color television images, overall system gamma or gradient plays an important role in faithful translation of the original image.[1] Arbitrary attempts to alter the system transfer characteristic can result in serious hue and saturation distortions. Because of the kinescope power-law transfer characteristic and restricted brightness range, it is neccesary to employ some system gamma correction.

The equipment described was designed to provide considerable flexibility in brightness gamma correction as well as hue and saturation modification. Although the amplifiers were designed specifically for use in color film reproduction, their operational flexibility should make them useful for live pickup cameras also.

Measurements show the typical color kinescope to be capable of a small-area brightness range of between 20 and 50 to 1 with a gamma characteristic of about 2.2. The brightness range is restricted on the high end by phosphor emission and allowable beam current, and on the low end by ambient light on the face of the kinescope.

Correction Gammas Needed

Assuming that a nearly linear overall system is desirable for pleasing reproductions, the pickup and transmission equipment must have a combined gamma of 1/2.2 or 0.45 to compensate for the 2.2 gamma of the kinescope.

For color television studio use, image orthicon cameras are most commonly employed. They are usually operated below the knee of the transfer curve, at which point they exhibit a gamma of about 0.65 and thus require an additional correction of 0.7 in the transmission system to achieve the desired 0.45 before being applied to the kinescope.

Flying-spot scanners, on the other hand, have an inherent gamma of unity and thus require a 0.45 gamma in the transmission system. The most recent figures for the vidicon film camera show a 0.6 characteristic requiring a 0.75 correction.

Brightness Ranges

Using the above-mentioned correction gammas for the transmission system in conjunction with the correct color filters for the pickup tube, colorimetrically correct transmission in accordance with NTSC Standards will be achieved provided the subject brightness range is kept within the 50-to-1 limitation imposed by the color kinescope.

In a live studio this is usually possible by careful control of lighting and reflectance values for the scene to be transmitted. Unfortunately, however, in film transmission the brightness range is not under control of the television broadcaster and may be as high as 180 to 1 for normal theater release prints, thus far exceeding the capabilities of the reproducing kinescope.

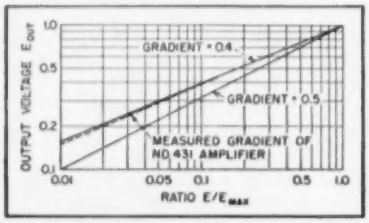


FIG. 1—Measured transfer characteristic of gamma correction amplifier

It has been shown[2] that using a lower correction exponent than needed to linearize the system will reduce the brightness range of the signal to a value within the handling capability of the kinescope. Such overcorrection results in a loss of saturation and some change in hue of the reproduced picture. This undesirable condition can be corrected by a masking amplifier following the gamma amplifier. Because of the nonlinear nature of the problem, it is difficult to compute the exact coefficients required and, therefore, experimentally determined coefficients are normally employed.[3]

Gamma Circuit Requirements

The demands placed on the gamma amplifier are extremely stringent. To allow for various pickup devices with provisions for overcorrection requires a gamma range of 0.4 (or lower) to 0.75. The circuit must follow the given characteristic over at least a range of 50 to 1, and preferably 100 to 1 for film reproduction.

Fortunately, a first-order approximation to the desired curve is visually acceptable.[4] It is possible to obtain the desired curves by mixing variable amounts of a true 0.4-power-law signal with a linear signal. In this manner approximation can be had to curves lying between 0.4 and unity.

Since three gamma amplifiers are required—one each for the red, green and blue channels—it is important that they be capable of producing similar curves, accurate to within at least 2 percent of each

Color TV Transmitters

By K. E. MULLENGER* and R. H. McMANN, JR.**

National Broadcasting Company
Development Laboratory
New York, N. Y.

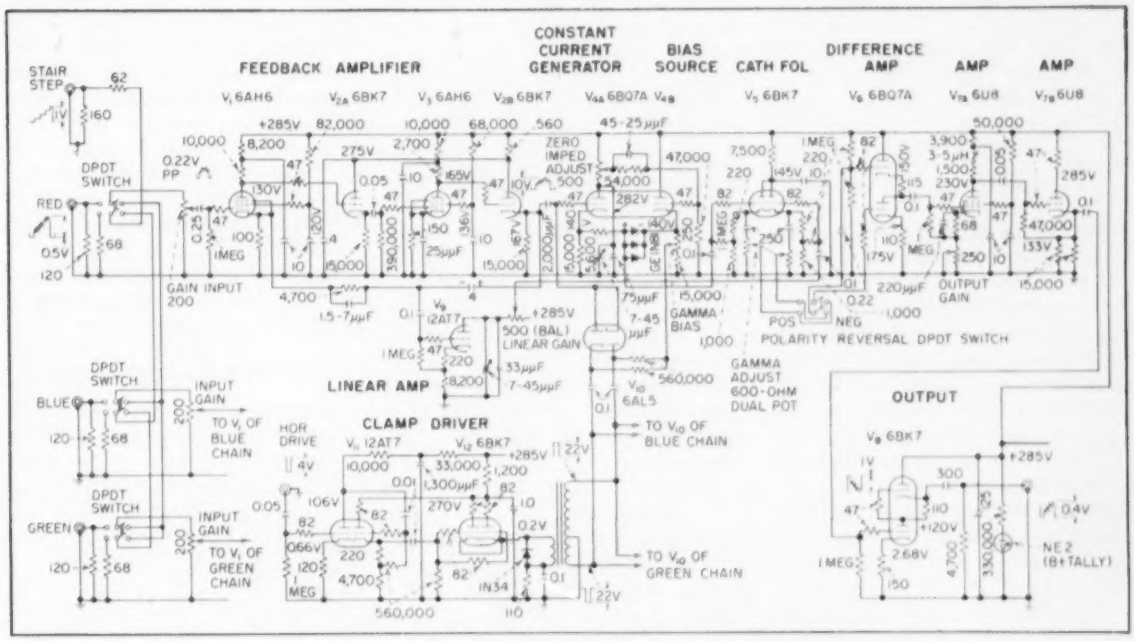


FIG. 2—Red-channel gamma or gradient correction amplifier. Blue and green channels are identical

other. Any dissimilarity would become immediately apparent as a hue error varying with brightness.

The voltage characteristic of a crystal diode driven from a constant-current source closely follows the 0.4 power law desired. This is the basis for the gamma amplifier described.

Gamma Correction Amplifier

Although the measured contrast range of a typical color film print can run as high as 180 to 1 and higher, as a practical matter stray light in the optics of a typical camera system will limit this range to perhaps more nearly 100 to 1. The gamma correction amplifier was therefore designed to provide a minimum gamma of 0.4 over a 100 to 1 input range. This provides some gamma overcorrection or brightness range reduction over and above that required to linearize the kinescope.

Figure 1 is a plot of the measured transfer characteristic of the amplifier. Small-signal gain at —40 db input referred to peak white is about 15. This points up the importance of maintaining excellent clamp and gain stability to avoid introduction of serious color unbalance due to such factors as voltage drifts or normal aging of the vacuum tubes.

A schematic diagram of the gamma amplifier is shown in Fig. 2. Tubes V_1, V_2 and V_3 are used in the feedback amplifier to give a gain of approximately 45 with good linearity and good stability. The feedback factor is 17 db. This amplifier drives the clamped grid of V_{4A}, used as a constant-current generator to drive three crystal diodes in parallel. Constant-current operation is achieved by virtue of the 5,600-ohm series resistor. Signal voltage drop across the nonlinear crystals is then a

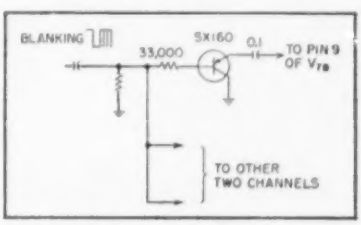


FIG. 3—Noise reduction circuit for blanking in gamma correction amplifier

* Now with Radio Corporation of America, New York, N. Y.
** Now with CBS Laboratories, Inc., New York, N. Y.

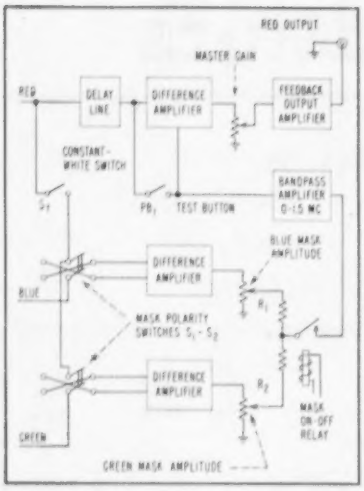


FIG. 4—Matrix amplifier for red channel

function[8] of signal current flow: $E = KI^{0.6}$.

Tube section V_{4B} is used as a zero-impedance bias source for the crystal cathode return.[8] The cathode of V_{4B} is adjusted to provide zero impedance by setting the ZERO-IMPEDANCE POT in the plate circuit of V_{4A} so as to cancel out all signal at the cathode of V_{4B}. Three crystals are operated in parallel as the nonlinear element to average out their characteristics and thereby provide a much better match between the amplifiers.

Tube V_5 is a dual cathode follower used to provide ganged variable gain control of the linear signal from V_6 and the nonlinear signal from the germanium diodes. The outputs of V_5 are mixed in V_6, a stable difference amplifier. Tube V_7 is a variable gain stage and V_8 is a shunt-regulated linear output stage.

Clamping in Gradient Amplifier

A common low-impedance clamp driver is used for all three channels so that any slight drift that might result in this amplifier (V_{11} and V_{12}) should be common to all three amplifiers. Clamp bias drift as a function of pulse amplitude is held to a minimum by using a balanced transformer and 1-percent resistors on the clamp bias return.

The d-c bias stabilization on the crystals is achieved by returning the clamp bias to the crystal bias source, which is the cathode of V_{11}. Any variation in bias voltage is reflected to the other side of the crystal through the constant-current driver, thereby maintaining a constant operating bias across the crystal.

Operating bias is adjusted with the 250-ohm potentiometer in the cathode lead of V_{4A}. This technique provides excellent stabilization over a wide range of d-c supply variation and is effective in minimizing gradient tracking variations between color primaries due to tube aging or changes in B+ supply voltage.

Flat-top clamp keying pulses are employed instead of a sine wave to reduce line-rate clamp noise (clamp restoring on noise during blanking). In use with a flying-spot scanner, clamp pulses should be delayed as much as possible externally to avoid clamping during phosphor decay noise that carries over into the early part of the blanking interval. Because this noise is stretched at least 15 times by the nonlinear element, it should be suppressed in level so that future clamps in the system will not set up on it and produce highly objectionable line rate noise. One practical circuit[7] that has been employed with this amplifier is shown in Fig. 3. Another practical solution would be to gate the multiplier phototubes with blanking pulses.

Transfer Characteristics

Adjustment for proper transfer characteristics can be made by inspection of a stair-case waveform fed through the amplifier or by the use of a blanking waveform and a precision video attenuator. With input gain adjusted to give 10 v peak white at the cathode of V_{4A}, the GAMMA BIAS control is adjusted

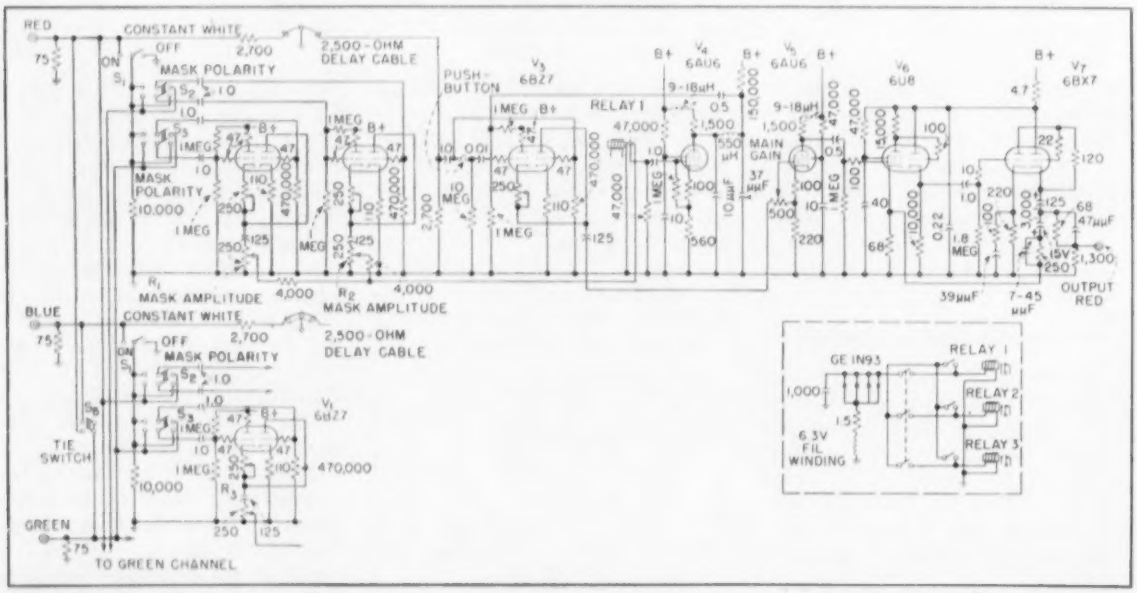


FIG. 5—Complete red-channel circuit for universal or matrix masking amplifier, with first stage of identical blue channel and input of identical green channel

for proper gain at −20 db input.

In summary, the gradient correction amplifier has the following desirable characteristics:

(1) Gain stability and linearity due to generous amounts of negative feedback.

(2) Minimum gamma of 0.4 over a 100-to-1 input contrast range, providing appreciable expansion of shadow detail in color film (15-to-1 stretch at 1 percent input referred to unity white gain).

(3) Continuously variable gamma from 0.4 to 1, providing flexibility in compensating for film gamma errors and general contrast variations.

(4) Improved gamma tracking between channels through the use of three nonlinear elements (germanium diodes) in parallel, thereby averaging out nonuniformities. Bandwidth over the 15-to-1 impedance range is slightly improved, with the resultant lower range impedance achieved by operating a number of nonlinear elements in paralled.

Matrix Amplifier

The matrix or masking amplifier used to correct for hue shift and loss of saturation caused by over correction of gamma is shown in Fig. 4 and 5. It has been designed with extreme flexibility in mind to permit any possible matrix equation to be set up easily.

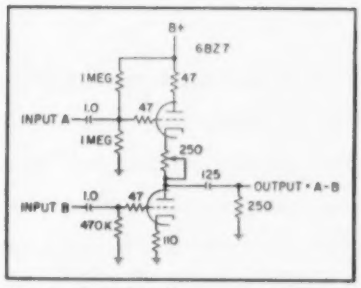


FIG. 6—Simplified diagram of difference amplifier used in each masking amplifier channel

The matrix amplifier uses three symmetrical difference amplifiers per channel, each like that in Fig. 6. These amplifiers are easy to convert from simple RGB matrixing to constant-white masking in which the correction signal disappears for white.[5] The constant-white feature can be extremely useful as it is possible to produce large hue and saturation changes in colored areas such as blue sky and green grass while only slightly affecting the more neutral flesh colors.

The masking signal is bandwidth-limited before being added to the main channel. This is possible as only color correction is desired and fine detail information continues to pass through the main channel. Bandwidth-limiting results in an improved signal-to-noise ratio as the signals add algebraically, while the noise adds as the root-mean-square. Compensation for the time delay in the bandwidth-limiting filter is accomplished by inserting wide-band delay cable in the main signal path.

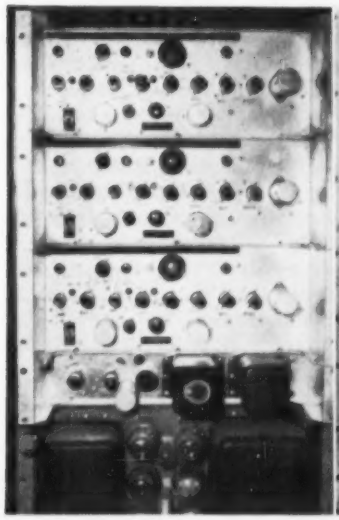
Difference Amplifiers

Reversing switches S_1 and S_2 at the inputs of the difference amplifiers in each channel in Fig. 4 allow the matrix signal polarity to be reversed, making it possible to reduce color saturation if desired. This feature can be especially useful with poor-quality film as it sometimes permits the correction of film faults which would otherwise render the films unusuable.

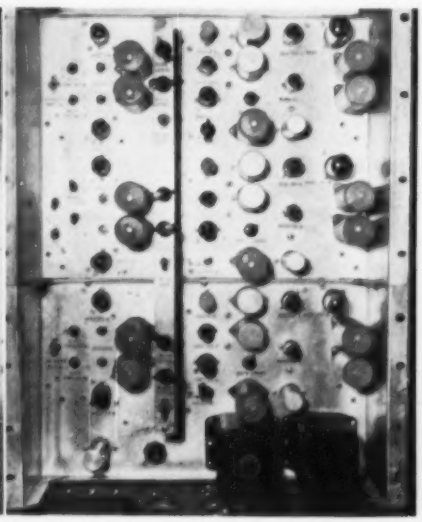
Pushbutton switches S_3 in each channel in Fig. 5 connect together the difference amplifier inputs for initial setup of the amplifiers. With signal applied and the buttons pushed, the balance potentiometers are adjusted for a null at the difference amplifier outputs. An additional switch S_4 ties all three channels together to insure equal input signals while adjusting the individual channel gains to equality.

Potentiometers R_1 and R_2 in each channel can be ganged in combinations[5] for ease in correlating manual masking adjustments with desired visual effects. The mask on-off relay permits masking to be inserted or removed remotely.

Acknowledgements are due to the management of NBC for permission to publish this paper, to G. M. Nixon, manager of the Engineering Development Laboratory, for his encouragement and to J. O. Schroeder for his assistance in video circuitry design.



Complete three-channel gamma correction amplifier



Complete matrix amplifier, with power supply below

REFERENCES

(1) Sidney Applebaum, Gamma Correction In Constant Luminance Color Television Systems, *Proc IRE*, p 1,185, Oct. 1952.

(2) W. L. Brewer, J. H. Ladd and J. E. Pinney, Brightness Modification Proposals for Televising Color Film, *Proc IRE*, p 174, Jan. 1954.

(3) Proposed Controls for Electronic Masking In Color Television, *IRE Convention Record*, 1955.

(4) B. M. Oliver, A Rooter for Video Signals, *Proc IRE*, p 1,201, Nov. 1959.

(5) F. N. Gillette, P. B. King and R. White, Video Program Recording, ELECTRONICS, p 90, Oct. 1950.

(6) L. Lax and D. Weighton, A Gamma-Control Circuit Using Crystal Diodes, *Jour IEE*, 99, p 804, 1952.

(7) Private Correspondence with W. G. Gibson of David Sarnoff Research Center; subject of U. S. Patent Application by George C. Sziklai and A. C. Schroeder.

(8) R. P. Burr, The Use of Electronic Masking In Color Television, *Proc IRE*, p 192, Jan. 1954.

noise

SUMMARY — Wide-band random-noise sources are useful in designing and testing receiving systems and their components. This article, second in a series, describes performance and frequency characteristics of hot-cathode arcs in gas-discharge tubes, photoelectron multipliers, noise diodes, glow-discharge noise sources and other devices

Part II

Equipment for

NOISE GENERATORS may be used to simulate signals or to provide a calibrated standard for measuring other noise. These uses differ in the amount of output power required.

In the first case the noise power needed is of the same order of magnitude as the power in the signal to be simulated, from microwatts to a few watts.

In the second case, the unknown power to be measured by comparison is typically the small amount contributed by the early stages of an amplifier. It is disadvantageous for a standard to be much larger than the quantity to be measured. Insertion of a large loss in the standard to obtain a match decreases the accuracy of the result.

Noise generators for determining the noise figures of amplifiers deliver at the most about 20 db more power than thermal noise rather than the 100 to 150-db increments needed to simulate typical signal sources.

Testing With Noise

One of the early uses of noise for signal simulation was in testing a broadband carrier telephone system.[1] Such a system, designed to transmit several hundred voice channels simultaneously by frequency separation, is awkward to load with actual talkers for a trial run. The composite signal when the modulated waves are superimposed does however resemble a noise wave occupying the same bandwidth.

It is feasible for testing to replace several hundred speech sources by a single wide-band noise source. The interference occurring in an idle channel is simulated by filtering out a narrow band of noise-frequency components from the noise-wave input by a band-elimination filter centered on the idle channel.[2-4] The output of the idle channel consists of the ambient noise from the transmission system plus the interference from cross-modulation of the other channels.

The ambient-noise component is measured with no input to the system and the increment caused by the cross-modulation is determined as a function of the applied noise load. A similar procedure can be applied to single-channel systems to obtain a distortion-against-frequency curve for specified loading conditions. An example is the noise behind the signal, a signal-dependent distortion observed in magnetic recording.

Previous Article

Characteristics and Origins of Noise, p 154, March 1956

Other Uses for Noise

The fact that a noise wave can in one measurement put a system through its paces with respect to a considerable frequency and amplitude range offers a speedup over obtaining data by a number of separate sine-wave measurements. Applications[5-6] include determinations of network characteristics, room acoustics, loudspeaker and microphone performance and distortion in recording and reproducing.

The method is particularly helpful in obtaining smoothed data for cases in which single-frequency waves exhibit fine structure variations of little practical interest. In acoustic response measurements in an auditorium, a slight shift in position of the receiver may make a large difference in the result when a single-frequency test wave is used but will not have much effect on the power received from a noise-band source.

In the synthesis of speech as in the vocoder or voder,[7] a noise generator provides a hiss which is shaped in its spectrum by proper controls to produce consonant sounds.

Noise generators in the range from near d-c to about 5 mc have

BY W. R. BENNETT
Bell Telephone Laboratories
Murray Hill, New Jersey

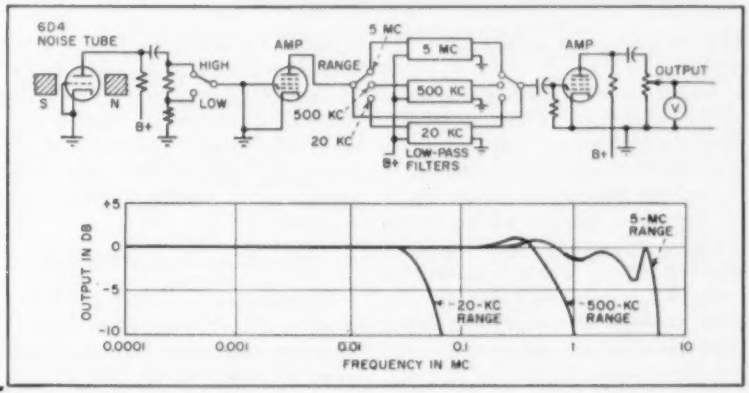


FIG. 1—Circuit (A) and spectral density (B) of noise generator using hot-cathode arc

Generating NOISE

been realized by amplifying the noise spectrum from a hot-cathode arc in a grid-controlled gas-discharge tube. Two or three stages with shaping of the frequency selectivity to obtain a uniform output band are sufficient for most uses.

Hot-Cathode Arcs

The main part of the noise arises from fluctuations in the dense layer of positive ions near the cathode. The frequency beyond which this noise begins to fall off varies inversely with the atomic weight of the gas. Ions can be produced almost instantaneously but have a finite life inversely proportional to their mobility. This varies inversely with atomic weight. The reciprocal of the lifetime determines the upper-frequency limit of the noise energy.

In early applications some difficulty was encountered with sharp resonance peaks associated with natural oscillation frequencies of the ions. It was demonstrated[9-10] that the resonant peaks could be suppressed and the high-frequency output increased by application of a transverse magnetic field from a permanent magnet enclosing the tube.

The magnetic field turns back to the cathode those electrons which would otherwise go directly to the anode without colliding with gas atoms. Removal from the anode current of electrons which would otherwise arrive immediately after being velocity-modulated by ionic oscillations breaks up the sharp resonance condition.

Another effect is to narrow and intensify the region of high ion density. Ionic oscillations of a frequency varying with the square root of the local ion density can occur.[11] The variations of density over the ionized layer result in a wide range of possible oscillation frequencies and high density values extend this range at the upper part of the band.

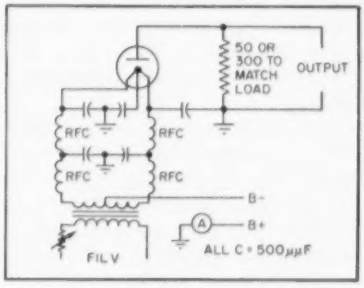


FIG. 2—Noise diode and its circuit

The Sylvania 6D4 miniature argon-filled triode has been extensively used as a hot-cathode arc noise source. Noise-generator units including this tube are available commercially with a choice of bandwidths. A typical circuit and its spectral response are shown in Fig. 1.[12]

Photoelectron Multiplier

To obtain a flat band beyond 5 mc it would be possible to amplify thermal noise with sufficient gain, bandwidth and linear range. It is simpler however to start with a noisier wide-band source. A cascade of secondary-emission multiplier stages following a photoelectric cathode[6] forms one convenient way since a large gain may be realized in a single tube structure.

A flashlight shining on the photoelectric surface serves to initiate wide-band shot noise which is amplified and slightly augmented by the multiplier stages. Constant power in the noise output requires a well-regulated power supply for the dynode voltages.

Noise Diode

Of the lower-power sources more commonly used as noise standards, the noise diode[13] has found a considerable field of application. It consists of a two-element vacuum tube operated at temperature saturation —that is, at sufficient anode voltage to collect electrons at the anode as

fast as they are emitted by the cathode.

Under these conditions the shot-noise equations as originally derived by Schottky for random emission of electrons are valid over a range of frequencies from about 10 kc up to frequencies at which finite electron transit time begins to exert an effect. For a considerable range white gaussian noise is available as from a current generator with average squared current

$$I^2 = 2 e I_0 b$$

where e is the electronic charge of 1.6×10^{-19} coulomb, I_0 is the diode current in amperes and b is the bandwidth in cps. The value of I_0 can be conveniently controlled by varying the filament current.

The noise diode is usually shunted by a resistance R to match the load. The available noise power from the diode alone is then

$$I^2 R/4 = e I_0 b R/2$$

Compared to thermal noise power kTb, where k = Boltzmann's constant and T = absolute temperature, the combination of noise diode and shunting resistance gives a noise ratio at 17 C of

$$n = [(e I_0 b R/2) + k T b]/ k T b = 20 I_0 R + 1$$

At the low-frequency end, the noise is contaminated by flicker effect and at high frequencies the noise falls off because of electron transit time effect, parasitic series lead inductance and shunt capacitance.

In narrow-band work it is feasible to tune out the reactive components at a particular operating frequency. The reduction from transit time can be evaluated and corrected by calibration. The Sylvania type 5722 noise-generating diode[14] is commonly used in this country and has been incorporated in commercially available noise-measuring devices. A typical circuit shown in Fig. 2 gives usable output up to about 500 mc. At the rated maximum anode current of 35 ma and a load resistance of 300 ohms, the noise power output is 23 db above thermal noise in the lower part of the frequency band.

Extension of noise diodes into the microwave range has been accomplished by a coaxial structure suitable for matching into a waveguide or coaxial transmission line. Several versions were developed in England.[15] Figure 3A shows their water-cooled disk-seal structure in which the copper disks may be directly incorporated into waveguide sections.

Microwave Noise Sources

The anode and cathode are hollow coaxial cylinders forming a broadband transmission line of impedance 138 $\log_{10}$ (r_a/r_c) ohms where r_a and r_c are the anode and cathode radii respectively. The cathode is heated from the inside by a fine coaxial tungsten filament.

Shot noise in the current between cathode and anode is propagated as a wave in both directions along the coaxial line. Matched untuned impedance terminations at the ends give the noise source broadband properties. The effect of electron transit time is small because of the small distances traveled and has been evaluated for calibration.

An American version of the coaxial noise diode[16] is shown in Fig. 3B. A coaxial structure similiar to the English tube is used but the central wire within the inner conductor is used as a filament lead, and the actual filament is a loop of tungsten wire between inner and outer conductors. The other filament lead is the inner conductor itself.

A mica capacitor inside the inner conductor bypasses the filament leads. The electron flow is from the filament loop to the outer conductor. With an anode voltage of 300 v, the filament emission is temperature-limited up to 100 ma.

The impedance of the coaxial line is 50 ohms. Noise outputs 20 db up on thermal noise are obtained at a few hundred mc. Electron transit time reduction of noise power amounts to 3 db at 3,000 mc. A tube based on this model is available commercially as the Bendix TT1.

A simplification in microwave noise measurements was introduced by Mumford.[17] He showed that the positive column in a low-pressure gaseous discharge is a stable noise source, which is uniform over a wide frequency band and has the right order of intensity for convenient comparison with the noise in typical microwave apparatus.

Positive Column of a Gas Discharge

The positive column contains electrons and ions in nearly equal concentration. Its maintenance depends on a continuing supply of electrons from the cathode. These may come from thermionic emission of electrons by the cathode and from secondary emission caused by positive-ion bombardment of the cathode surface.

In the latter case the emitted electrons produce positive ions to make the process self-sustaining. The electrons entering the positive column have acquired sufficient energy to ionize gas molecules and excite emission of the light which gives this region its luminous appearance.

The relatively long free path enables the electrons to gain more energy during their free flights than they lose during collisions. They thus build up to an equilibrium energy considerably higher than either the neutral gas molecules or the positive ions.

The higher average energy defines a correspondingly higher electron temperature. Electron tem-

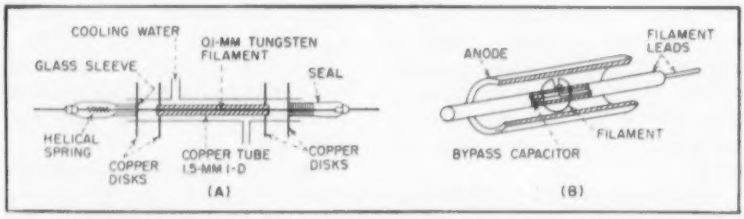


FIG. 3—Disk-seal coaxial noise diode (A) and coaxial-line noise diode (B)

peratures of approximately 12,000 K are typical; the positive column emits thermal noise as if it were a resistance at this elevated temperature. The ratio of this temperature to ordinary room temperature is about 40. The resulting thermal noise source therefore has about 16 decibels more available noise power than a resistor at room temperature.

Practical Device

Mumford inserted a commercial fluorescent lamp in a rectangular waveguide as shown in Fig. 4A. The positive column crossed the interior of the guide in the longer dimension with its axis parallel to the magnetic vector. The two cathodes energized from a d-c source were outside the guide and were surrounded by cylindrical metal shields which formed waveguides beyond cutoff and thereby restricted the microwave circuit to the positive column only.

The susceptance component of the discharge was tuned out by a piston and trimming screw. The conductance component was adjusted to match the waveguide by varying the direct-current supply. When the match was made at 3,960 mc the standing-wave ratio was less than 3 db from 3,700 to 4,240 mc.

The spectral density of the noise power available from the discharge was found to be uniform with frequency over the microwave range tested. The amount of power was substantially independent of the direct current over a range from 40 to 140 ma. It was almost independent of the ambient temperature of the waveguide circuit, the variation amounting to −0.055 db per degree centigrade.

Thirty-one different colored lamps were within plus or minus ½ db of each other in output. The source of the noise is the gaseous discharge and is not affected by the fluorescent material which is provided to convert from ultraviolet radiation to the visible band.

Further Investigation

The constancy with frequency extends over an even wider range than explored in Mumford's original experiments. Isolated measurements in a 65-mc i-f circuit indicated that the same noise density was present. The noise was coupled into a tuned circuit by wrapping a coil of wire around the outside of the tube.

Johnson and Deremer[16] extended microwave application to 26,000 mc. Specially constructed elongated small-bore tubes were constructed to fit the smaller waveguides. A type of mounting recommended is illustrated in Fig. 4B.

The tube is inserted through the broad faces of the guide in the plane formed by the vertical and horizontal axes and its axis makes a small angle with the longitudinal axis of the guide. The 20-db or more attenuation through the discharge gives a good waveguide termination without the use of any tuning elements and insures a broadband source. With a 10-deg angle of an argon-discharge tube, a maximum vswr of 1.1 was found over the recommended band of the guide. The shot noise flowing along the tube axis makes only a small contribution in this case since its direction of flow is at an angle of 80 deg with the electric vector in the guide. This is an advantage since the shot noise is dependent on the electron transit phase angle and hence would introduce a component variable with frequency.[16]

Earlier work on standards for microwave noise measurements made use of nonoscillating klystrons, hot wires and silicon crystals as noise sources. These were either narrow band, not noisy enough or required calibration and have become superseded.

There are still some applications made of resistors heated in ovens and matched into waveguide to serve as thermal noise sources up to 1,000 C.[20-21] The increment over ordinary thermal noise obtained in this way is only a few db. Recent work in which the waveguide itself is heated offers usefulness in highly accurate measurements of low noise figures.

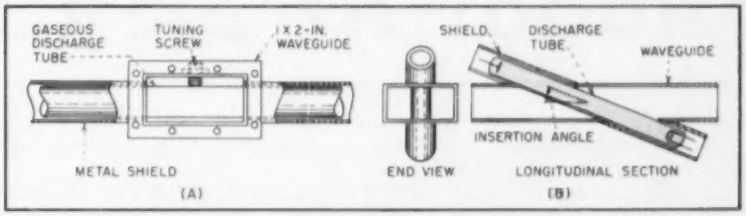


FIG. 4—Glow-discharge noise source for microwave frequency (A) and mounting of small-bore tube to generate shf noise (B)

References

(1) E. Peterson, Gas-Tube Noise Generator for Circuit Testing, *Bell Labs Rec*, **18**, p 81, Nov. 1939.

(2) W. R. Bennett, Cross-Modulation in Multichannel Amplifiers, *BSTJ*, **19**, p 587, Oct. 1940.

(3) W. J. Albersheim and J. P. Schafer, Echo Distortion in the F-M Transmission of Frequency-Division Multiplex, *Proc IRE*, **40**, p 316, 1952.

(4) W. R. Bennett, H. E. Curtis and S. O. Rice, Interchannel Interference in F-M and P-M Systems Under Noise Loading Conditions, *BSTJ*, **34**, p 601, May 1955.

(5) E. Cook, White Noise Testing Methods, *Audio Eng*, **34**, p 13, March 1950.

(6) C. R. Ammerman, Direct Measurement of Band-Width, *Electrical Eng*, **68**, p 207, March 1950.

(7) H. W. Dudley, R. R. Riesz and S. S. A. Watkins, A Synthetic Speaker, *Jour Franklin Inst*, **227**, p 739, June 1939.

(8) J. D. Cobine and C. J. Gallagher, Noise and Oscillations in Hot Cathode Arcs, *Jour Franklin Inst*, **243**, p 41, Jan. 1947.

(9) C. J. Gallagher and J. D. Cobine, Effect of Magnetic Field on Noise and Oscillations in Hot Cathode Arcs, *Jour Appl Phys*, **18**, p 110, Jan. 1947.

(10) J. D. Cobine and J. R. Curry, Electrical Noise Generators, *Proc IRE*, **35**, p 875, Sept. 1947.

(11) L. Tonks and I. Langmuir, Oscillations in Ionized Gases, *Phys Rev*, **33**, p 195, 1929.

(12) A. P. G. Peterson, A Generator of Electrical Noise, *Gen Radio Experimenter*, **26**, p 1, Dec. 1951.

(13) J. Moffatt, A Diode Noise Generator, *Jour IEE*, Part IIIA, **93**, p 1,335, 1946.

(14) R. W. Slinkerman, Temperature-Limited Noise Diode Design, *Sylvania Technologist*, **2**, p 6, Oct. 1949.

(15) R. Kompfner, J. Hatton, E. E. Schneider and L. A. G. Dresel, The Transmission Line Diode as a Noise Source at Centimeter Wavelengths, *Jour IEE*, Part IIIA, **93**, p 1,436, 1946.

(16) H. Johnson, A Coaxial-Line Diode Noise Source for UHF, *RCA Rev*, **8**, p 169, March 1947.

(17) W. W. Mumford, A Broad-Band Microwave Noise Source, *BSTJ*, **28**, p 608, Oct. 1949.

(18) H. Johnson and K. R. Deremer, Gaseous Discharge Super-High Frequency Noise Sources, *Proc IRE*, **39**, p 908, Aug. 1951.

(19) P. Parzen and L. Goldstein, Current Fluctuations in D-C Gas Discharge Plasma, *Phys Rev*, **79**, p 190, 1950.

(20) G. Lynch, Primary Standard Thermal Noise Generator, *Radio-Electronic Eng*, p 10, Nov 1952.

(21) J. J. Freeman, Noise Comparator for Microwaves, *Radio-Electronic Eng*, p 11, Jan 1953.

Radar AFC System Uses

SUMMARY —— Servo system, controlled by signals from radar i-f amplifier, tunes wide-range local oscillator operating in L-band. Bistable multivibrator circuit provides automatic switching from search to afc. A reactance tube senses changes in intermediate frequency

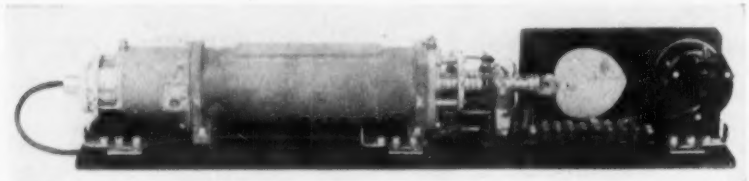
RADAR RECEIVER local oscillators must be tuned to a frequency that differs from the magnetron frequency by the intermediate frequency. Flexible local-oscillator tuning is required not only because the natural frequency of a fixed-frequency magnetron may differ from that of other magnetrons of the same type but also because tunable magnetrons can operate anywhere within a frequency band as wide as 200 mc. In addition magnetron frequency drifts usually occur while the magnetron warms up.

The motor-driven mechanically tuned system to be described consists of electronic control circuits which control a driving motor, to tune the system over wide ranges to within a few megacycles of the desired frequency (search function). The system then switches to a precise sensing method and adjusts the system to within a few kilocycles of the desired frequency (afc function).[1] An alternating voltage whose amplitude and phase are functions of the amount and direction of the deviation from the desired frequency is applied to the control phase of a two-phase motor for afc action.

The transition from the search function to the afc function is accomplished in the control circuits.

Both afc and switching from search to afc described in terms of a circuit designed for the frequency control of stable local oscillators (stalo) in radar receiving systems with moving target indication (MTI).

Local oscillators can be built to meet the stability requirements of MTI receiving systems for L-band and S-band operation using any of several types of conventional uhf tubes. Figure 1 shows such an oscillator. Its frequency is determined by the high-Q external cavity. The motor shown, rotates the cam which positions the spring-loaded plunger in the cavity. A complete rotation of the cam causes the oscillator to tune through its search frequency range twice. In a typical case a band of 100 mc is searched twice.



Heart-shaped cam actuates plunger in coaxial oscillator to change frequency

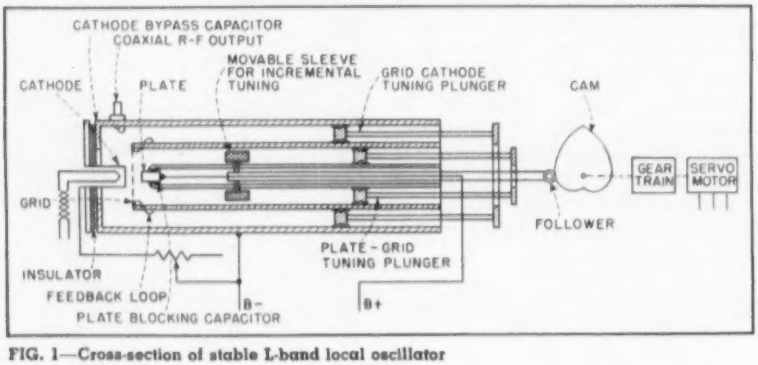


FIG. 1—Cross-section of stable L-band local oscillator

Searching

In the automatic search condition, a voltage of constant amplitude and phase is applied to the control phase of the motor. The cam rotates in one direction only, and the oscillator frequency sweeps through the band cyclically.

System alignment is apparent when signals appear in the i-f circuits of the receiver. When tuning automatically, a voltage developed by these signals in the i-f channel is used to actuate a relay, which switches the control phase of the tuning motor from the source of search voltage to the afc circuits.

Afc Circuit

To tune the local oscillator precisely, the afc system must be able to operate over the range of frequencies within the pass band of the i-f amplifier.

Since receiver i-f bandwidths and gain characteristics are governed by other considerations, it is common practice to use a separate i-f amplifier whose bandwidth is equal to that over which afc is desired,

Mechanical Tuning

By JOHN L. CONFALONE
Airborne Instruments Laboratory
Mineola, N. Y.

and

WILLIAM R. RAMBO*
Stanford University
Stanford, California

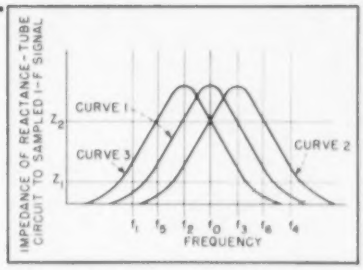
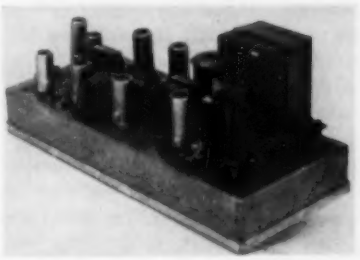


FIG. 2—Variation of impedance-frequency characteristic of resonant circuit



Control circuits and servo amplifier are combined on one chassis

and whose gain characteristic is suited to the afc requirement. In this circuit the output signal from the receiver i-f is amplified in a pentode stage and applied to a resonant circuit whose frequency is controlled over a small range by a reactance tube.

If the resonant-frequency is varied by the application of an a-c modulating voltage to the reactance tube grid, the impedance of the circuit, and the gain of the amplifier will vary. Thus, the voltage developed across the plate circuit of the reactance tube will vary in amplitude at the frequency of the modulating voltage, though the i-f signal applied to the amplifier grid is constant in amplitude and frequency. This voltage variation is detected, amplified in a servo amplifier, and applied to the control phase of the tuning motor. The modulating voltage itself is applied through a 90-degree phase-shifting network to the second winding of the motor.

Frequency Characteristics

Curve 1 of Fig. 2 shows the impedance-frequency characteristic centered about f_0, which is the resonant circuit midfrequency when the modulating signal has zero value, and is also the passband midfrequency of the receiver i-f amplifier. Curve 2 shows the impedance-frequency characteristics shifted to a new position, centered around f_2, which is the resonant circuit midfrequency when the modulating signal attains its maximum negative value. Curve 3 shows the impedance-frequency characteristic shifted to a position centered about f_3, which is the resonant circuit midfrequency when the modulating signal attains its maximum positive value. The impedance-frequency characteristic can be considered to move between curves 2 and 3 at the sinusoidally varying rate established by the modulating signal.

If, because of local oscillator detuning, the intermediate frequency is at some value lower than f_0, such as f_5 of Fig. 2, then as the resonant frequency of the reactance-tube circuit decreases from f_5 to f_2, the circuit impedance to the i-f signal increases from Z_1 to Z_2. However, if the intermediate frequency is at some value higher than f_0, such as f_6, then as the resonant frequency of the reactance-tube circuit decreases from f_6 to f_2 the circuit impedance decreases from Z_2 to Z_1.

Fig. 3 shows the transfer characteristics (*a*) of the reactance-tube circuit. When a sinusoidal modulating voltage (*b*) is applied to the grid, the resonant frequency of the reactance-tube circuit (including the pentode plate circuit) varies sinusoidally (*c*) as shown.

In the ranges between either f_1 and f_2 or f_3 and f_4 (Fig. 2), the impedance of the reactance-tube circuit to the i-f signal, and therefore the gain of the pentode, also changes sinusoidally at the rate of the modulating signal on the reactance-tube grid. The output signal of the servo amplifier, which results from detection and amplification of the voltage variation across the reactance-tube resonant circuit, is therefore an approximate sinusoidal voltage at the modulating frequency. This voltage is either in phase or 180 degrees out of phase with the modulating voltage depending whether the intermediate frequency is in the range f_1 to f_2 or f_3 to f_4.

Servo Output

Figure 4 shows the phase relations existing between the modulating voltage V_m, at the reactance-tube grid (Fig. 4A), the variation in resonant frequency of the reactance-tube circuit (Fig. 4B), the output signal V_o of the servo amplifier for intermediate frequencies between f_1 and f_2 (Fig. 4C) and the output signal of the servo amplifier for intermediate frequencies between f_3 and f_4 (Fig. 4D).

The output signal of the servo amplifier is used with phase sensing which causes cam rotation in the direction producing the right change in local-oscillator frequency. This is reflected in the sampled i-f as a shift toward the center resonant frequency of the reactance-tube circuit.

As the sampled i-f signal approaches f_0, the waveform of the varitaion of the detector output voltage becomes complex and at f_0 approximates the double-frequency characteristic of a full-wave rectifier. Thus, at this point, tuning action ceases since only the fundamental frequency component is selected for amplification in the following servo amplifier.

Driving Voltage

The amplitude of the variation of the detector output voltage is reasonably constant for an i-f signal

* Formerly with Airborne Instruments Laboratory.

whose frequency is anywhere along the slope of the resonance curve (for example, anywhere in the region f_1 to f_2 in Fig. 2), though the average value of the i-f carrier signal in the circuit may change appreciably in accordance with average circuit impedance. Thus, ample drive voltage for the tuning motor can be developed over a wide frequency range in incoming signals if the Q of the resonant circuit is sufficiently low. By deliberately lowering the Q with a shunting resistor, afc action has been obtained over a band of ±7 mc centered on an intermediate frequency of 30 mc. The afc channel i-f amplifier should be equally wide if this characteristic is to be used.

If the incoming i-f signal frequency is in the region f_1 to f_2 of Fig. 2, the available driving voltage is reduced by the decrease in the modulating-frequency component of the resulting complex voltage variation in the detector output. There is a small frequency range centered at midband in which there is insufficient output voltage to drive the motor. The width of this notch or null region is dependent upon the gain in the following amplifier, the extent of the electronic tuning and Q of the tuned circuit and the incoming signal level. In the practical case, it is small compared with the passband of normal receiver i-f strips.

When the frequency of the incoming i-f signal is outside the range f_1 to f_4 in Fig. 2, the available driving voltage is too low to actuate the tuning motor. As such regions are approached, it is necessary that a transfer to the search condition be effected.

Search to Afc

There is available in the output of the crystal rectifier (*CR* in Fig. 5) a d-c voltage whose amplitude is related to the amplitude of the i-f signal appearing across the reactance-tube circuit. This voltage can be used to control the state of a bistable multivibrator[3] and, through a plate-circuit relay, the application of either a search or afc voltage to the servo amplifier and control motor. In the absence of an incoming signal, the relay contacts apply a constant-amplitude

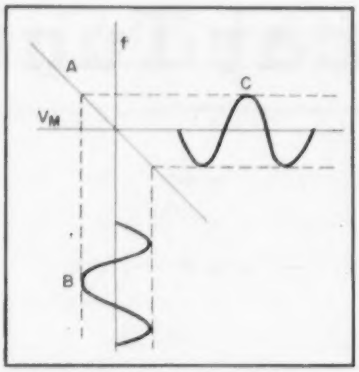


FIG. 3—Transfer characteristic of reactance-tube circuit

search voltage. When a signal appears that exceeds a preset level, the relay is actuated and connects the motor to the afc circuit for precise tuning.

The problem may be complicated in the case of a cam-driven tuning mechanism. If an oscillator is controlled over a wide tuning range, it frequently is possible to establish several tuning relationships that provide an i-f signal of proper frequency. The local-oscillator frequency may be either higher or lower than the transmitter frequency by an amount equal to the intermediate frequency of the system, and either condition can be intercepted on both sides of the cam. This adds to the complexity, because the direction of the frequency change for a given direction of cam rotation is reversed on the two sides. As a result, an i-f signal can appear at four cam positions. At two of these four positions an unstable condition will exist wherein the sensing of the afc circuit will be incorrect. The resulting afc action will change the i-f away from the desired value to a value at which the search condition is reinstituted. The system is then returned immediately to the unstable afc state, and a continuing oscillation will result.

In the present circuit, the situation is treated by applying a sharp triggering waveform, through a second set of contacts on the search-afc relay, to a flip-flop circuit. This circuit reverses the phase of the modulating voltage applied to the reactance-tube grid each time the transition from afc to search is made. The circuit does not operate when the condition shifts from search back to afc. Thus, if an unstable point is encountered, the momentary transition back to search is made. However, on the second try a moment later, the point has become stable because of the reversal in modulating voltage phase and afc sensing, and normal afc action results.

The triggered phase-reversal action can be accomplished electronically or with a stepping relay combination. Figure 5 shows an electronic arrangement. Modulation voltages 180 degrees out of phase are introduced into the grid circuit of a triggered bistable multivibrator called the phase reversing multivibrator. The phase of the output voltage (a-c component across common cathode resistor *R*) depends on the section that is conducting. A phase change occurs with each transition from

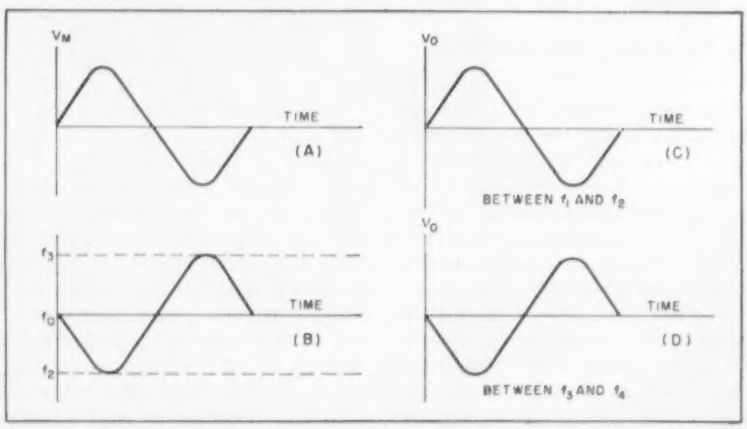


FIG. 4—Phase comparison between modulating voltage (A), reactance-tube resonant frequency (B) and servo output (C) and (D)

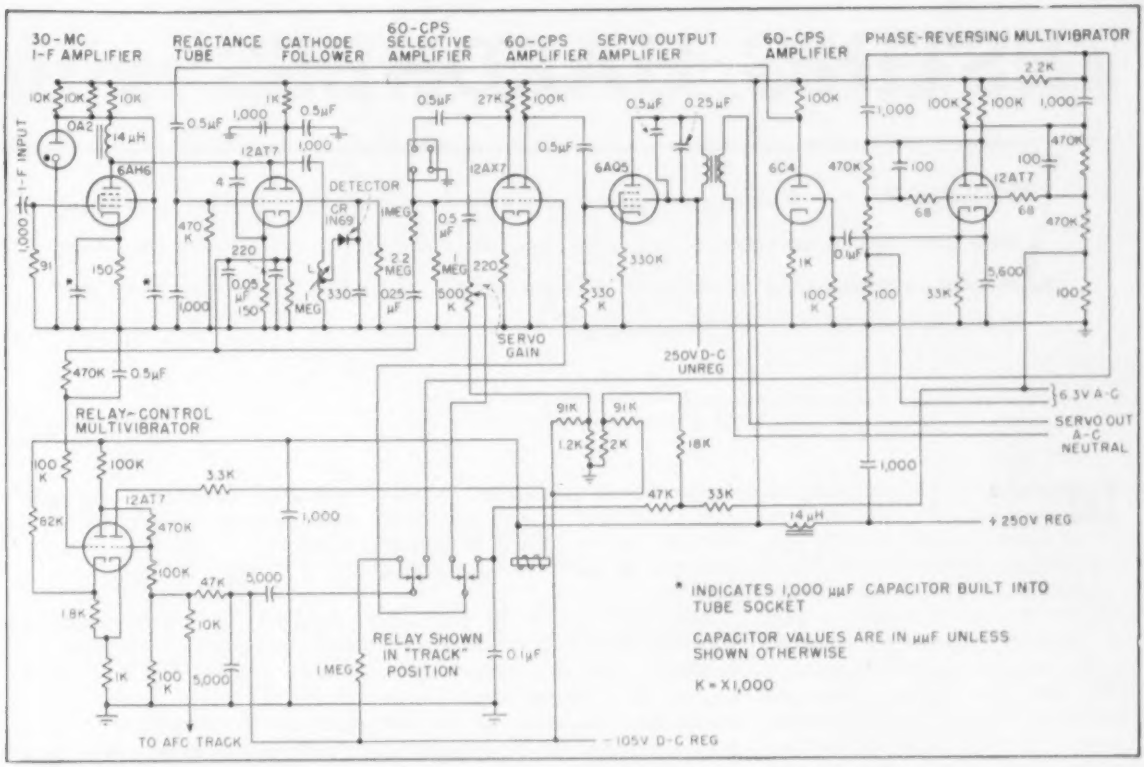


FIG. 5—Complete circuit provides frequency deviation detection and electronic control over search-afc transition

the search to afc condition.

Figure 5 shows the complete afc circuit embodying the features described. This circuit has been used with the oscillator also described and was tuned (for frequency searching) over a 200-mc range. The afc pull-in range was ±1.7 mc and the afc loop was adjusted to hold the intermediate frequency within ±50 kc of that established by the center frequency of the reactance-tube circuit (adjustable by L).

Figure 6 shows oscilloscope photographs of waveforms at the output terminals of the servo amplifier for different tuning conditions. These photographs were taken while the i-f signal was pulsed at 300 pps using 2-μsec pulse widths.

The input amplifier and reactance-tube circuits were designed to work at a 30-mc intermediate frequency. Since a 115-volt, 60-cps tuning motor was used, a related 60-cps voltage was used to modulate the reactance tube.

An input signal of 2 volts peak applied to the reactance-tube circuit will develop an output voltage of about 20 to 40 volts at mid-frequency. The exact value depends on the input signal, the resonant impedance of the circuit and so forth. The voltage variation in this signal at the modulation frequency depends upon the midfrequency amplitude of the i-f signal and the frequency excursion of the reactance-tube circuit (generally held to 0.5 to 1 mc). It is usually approximately a few volts. Sufficient gain must be present in the following servo amplifier to raise this level to the normal motor voltage.

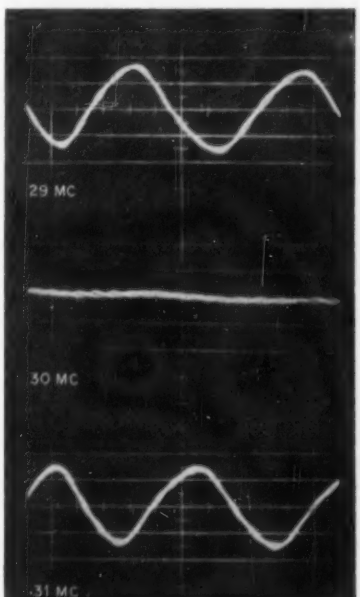


FIG. 6—Servo amplifier output waveforms at null and at either side of null

It is desirable that the reactance-tube circuit exhibit a relatively constant Q at all frequencies in the i-f passband. This is facilitated by the triode grounded-grid reactance-tube circuit.[2]

In radar systems, the input signal is generally pulsed. With pulsed inputs, the d-c plate voltage for the input amplifier and reactance tube should be low (100 to 150 volts).

References

(1) J. Gregg Stephenson, Combined Search and Automatic Frequency Control of Mechanically Tuned Oscillators, *Proc IRE*, 38, p 1,314, Nov. 1950.

(2) Chance, Hughes, MacNichol, Sayre and Williams, "Waveforms," MIT Rad Lab Series, McGraw-Hill Book Co. Inc., New York, 1949.

(3) Harvard Radio Research Lab Staff, "VHF Techniques", Vol. 1, p 498, McGraw-Hill Book Co. Inc., New York, 1947.

TESTING HARDNESS with

SUMMARY — Electronic hardness tester incorporating second-harmonic flux gate magnetometer accurately measures magnetic retentivity of steel tubing in which this characteristic is proportional to hardness. Readings are independent of surface conditions

MEASUREMENT of permeability, as a basis for hardness testing of ferrous metals, has had considerable application in industry.

Most methods employ an inductor or transformer into which a part is inserted for testing. Since alternating currents are employed in this procedure, only the metal near the surface of the object to be tested exerts an influence on the test results. At 60 cps, the flux penetration is only about 0.2 inch for a typical steel, according to the formula $S = 1.98\sqrt{\rho/\mu f}$, where S is depth of current penetration in inches (where current is $1/e$ times that at surface), ρ is resistivity in microhm-centimeters, μ is relative permeability and f is frequency in cps.

When the part to be tested is perfectly homogeneous, this characteristic offers no particular difficulty. This is also true if only the surface properties of the test piece are of interest. Unfortunately, many steel parts have a surface condition which, while it may be only slight, can affect the permeability measurements out of all proportion to the part of the total mass which it represents, thus giving erroneous and inconsistent test results.

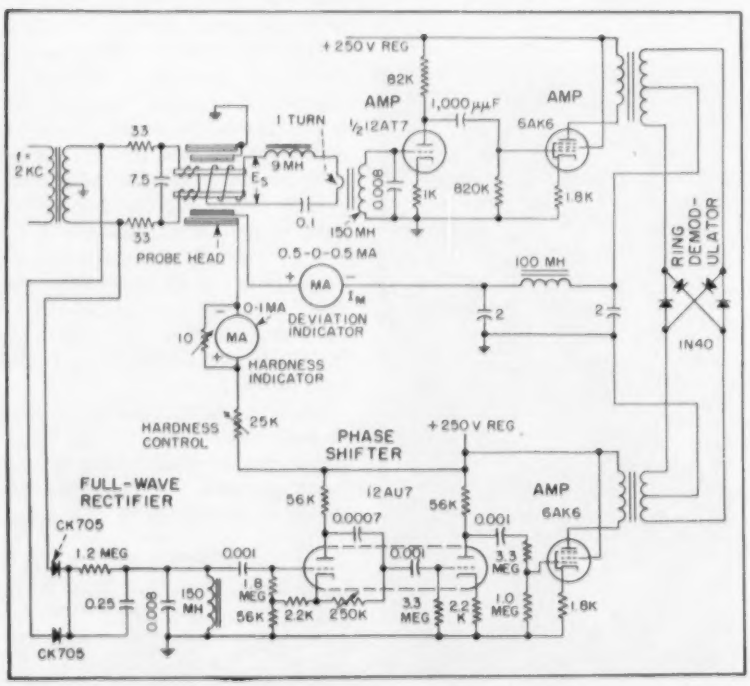


FIG. 1—Circuit of hardness tester. Readings proportional to hardness are obtained from either meter, depending on technique of use

New Method

An electronic hardness tester has been developed to overcome, on special applications, some of the limitations noted above. It could be termed a d-c tester as it operates on the principle that with certain magnetic materials, magnetic retentivity is proportional to hardness.

In the method under discussion, the metal part to be tested is first placed in a coil and magnetized. Discharging a large bank of capacitors through the coil saturates the part magnetically so that results are consistent in this respect. The magnetic field created by the part is then measured with a flux gate magnetometer. There is generally no relative movement between the part and the magnetometer probe during the test.

Operating Principle

The unit described is called a second-harmonic flux gate magnetometer. The basic circuit is shown in Fig. 1. The cores are two identical high-permeability elements in the form of rods. The primary windings are wound directly on the individual cores and connected to a 2-kc signal generator. The secondary winding is wound over both cores, and delivers voltage E_s having the frequency $2f$, where f is the 2-kc input. The output current I_m, derived from a phase-sensitive rectifier circuit in the amplifier, is measured by an

Flux Gate Magnetometer

By J. P. ISAACS
Norris-Thermador Corp.
Los Angeles, Calif.

and

GEOFFREY GREY*
William Miller Instruments, Inc.
Pasadena, Calif.

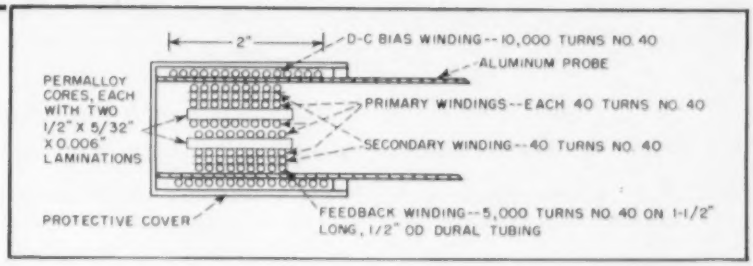

2"
D-C BIAS WINDING--10,000 TURNS NO. 40
ALUMINUM PROBE
PERMALLOY CORES, EACH WITH TWO 1/2" X 5/32" X 0.006" LAMINATIONS
PRIMARY WINDINGS--EACH 40 TURNS NO. 40
SECONDARY WINDING--40 TURNS NO. 40
PROTECTIVE COVER
FEEDBACK WINDING--5,000 TURNS NO. 40 ON 1-1/2" LONG, 1/2" OD DURAL TUBING

FIG. 2—Probe construction details. Spacings and insulating techniques are critical

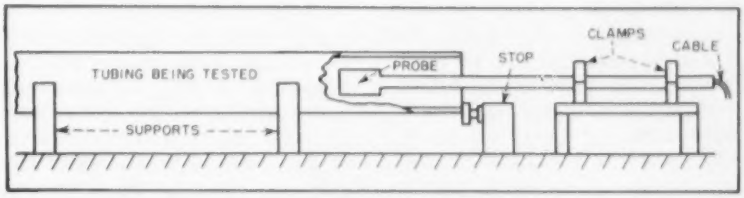


FIG. 3—Method of using probe for testing hardness of steel tubing

ammeter serving as a deviation indicator.

Under no-signal conditions (zero flux), the two voltages induced in the secondary are identical in magnitude and waveform and therefore balance each other. When a flux is present, the voltage waves become dissimilar and a voltage E_s, composed of even harmonics of the fundamental frequency f, appears at the input to the amplifier. This arrangement is sensitive to the direction of the flux since the phase of E_s reverses when the direction of the flux is reversed.

Construction of the special probe used for checking hardness of steel tubing is shown in Fig. 2 and 3. Each primary winding of the probe consists of 40 turns of No. 40 copper wire wound on small Permalloy laminations. These are laid side by side and connected in opposition. The secondary is a single 40-turn winding laid over the primaries.

Operation

Whenever an external magnetic field is present, a second harmonic (4-kc) voltage is present at the secondary. This is coupled to the amplifier through a transformer and filter, the other even harmonics being rejected. This 4-kc signal is amplified and applied to a ring demodulator using 1N40 diodes. The ring is also supplied with a 4-kc reference signal through a second amplifier excited from a selectively filtered full-wave rectifier using two CK705 crystal diodes. A phase-shift circuit is provided in this second amplifier so that the phase relationship between the two currents applied to the ring demodulator can be adjusted.

In operation, the output of the demodulator is filtered and fed back, in the interests of linearity, to the probe by means of a 5,000-turn winding applied over the previous windings. This feedback current is polarized and its magnitude and direction are indicated on a zero-center meter. The deflection of this meter is directly proportional to the intensity of the magnetic field of the metal sample being tested and hence to the hardness (except as noted previously).

To provide increased flexibility, an additional winding of 10,000 turns was placed over the previous windings (supported by the aluminum tubing in which the other windings are mounted). This winding is supplied from a regulated d-c source and a rheostat is connected in series to control the current.

In practice, the probe is inserted into the metal part being tested (a piece of special steel tubing) and the rheostat adjusted until the field produced by the 10,000-turn winding bucks out the external field and the deviation meter reads zero. The current through this coil is then read on the hardness indicator.

Applications

This method is particularly adaptable to checking the average hardness of tubing as it is easily magnetized and the probe can be placed inside. The lateral position of the probe is then not critical if the walls of the tubing are uniform.

Many other applications are possible as long as the object to be tested can be magnetized by convenient means and the magnetic retentivity is reproducible. In these cases, the position of the probe relative to the test piece may be much more critical than in the case of the tubing. As a practical matter, the hardness of steel test pieces must be above Rockwell C 40 if consistent results are to be obtained.

The flux gate magnetic hardness tester was developed in conjunction with William Miller Instruments, Inc., Pasadena, California, who now manufacture the probe. George Downs, formerly chief engineer with that organization, suggested the circuits and method.

* Now with Computer Division, Bendix Aviation Corp., Los Angeles, Calif.

Using TRAVELING-WAVE

By ROGER E. WHITE
Roger White Electron Devices, Inc.
Ramsey, New Jersey

SUMMARY —— Characteristics of traveling-wave tubes make them adaptable to many applications in radar and microwave systems as modulators, mixers and power-level limiters with increased circuit efficiency

TRAVELING-WAVE TUBES are functionally broadband, high-gain, microwave amplifiers. However, their characteristics make them useful as receiver input r-f stages, transmitting tubes, modulators, mixers, limiters and oscillators.

A curve of gain versus frequency for a typical S-band amplifier tube is shown in Fig. 1A.

The magnitude of gain obtainable is primarily a function of beam current and tube length. However, leakage around coaxial connectors and stem leads place a practical limit on the usable gain obtainable. In low-noise designs, low gain is often desirable to extend the dynamic range of the tube, since dynamic range is determined by the ratio in db of saturation power to noise power, minus tube gain.

In high-power designs, excessive magnet power is required to focus the beam over the lengths needed to obtain high gains. In addition, power tubes are operated at voltages above those required for synchronous velocity and the large reduction in velocity along the beam tends to limit gain. Both low-noise and high-power tubes are customarily designed at gains in the order of 20 to 25 db. Intermediate level tubes may provide gains as high as 45 db.

Bandwidth

To obtain gain, it is necessary that the signal velocity be matched to electron velocity, and if wide bandwidths are to be obtained, it is necessary that the signal velocity be the same at all frequencies. Velocity relationships, which are proportional to synchronizing voltage, of the tube of Fig. 1A are shown in Fig. 1B. Increase in velocity at lower frequencies determines the lower frequency limit of the gain curve. A second, more complicated, relationship causes the gain to fall as signal wavelength decreases in proportion to the helix diameter. This causes a fall-off in gain at higher frequencies. Careful design of these and other parameters will produce a gain-frequency characteristic as shown in Fig. 1A. Such a characteristic is desirable in r-f amplifier stages in receivers, in power amplifier stages for multichannel or tunable transmitters, in amplifying the output of signal generators and in increasing the sensitivity of measurements at low levels.

An increase in electron velocity obtained by increasing the accelerating voltage as indicated in Fig. 1B, will increase gain at low frequencies at the expense of gain at the high frequencies. This is known as operation in the dispersive region and a tube designed specifi-

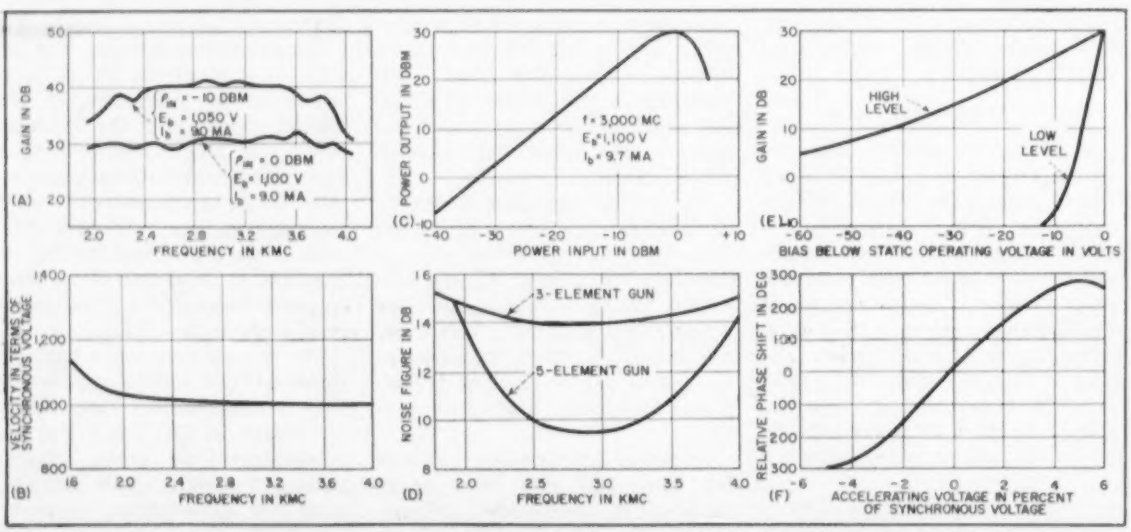
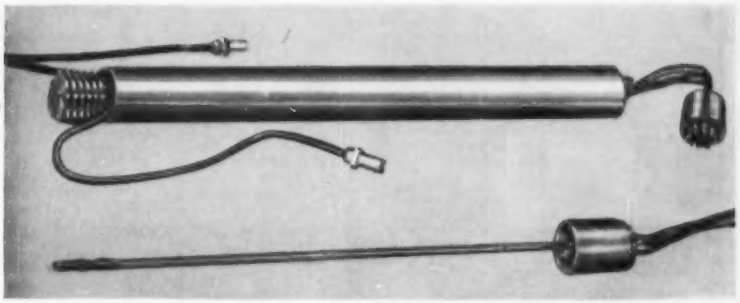


FIG. 1—Typical traveling-wave tube characteristics show value of tube in wide variety of applications described in text

TUBES



Traveling-wave tube with helix and electron gun assembly shown in foreground

cally for operation in this region as a voltage-tunable bandpass amplifier is known as a dispersive tube. In this type of operation, bandwidth may be restricted to values of 10 to 20 percent of the operating frequency.

Power Output

The power levels at which traveling-wave tubes can be designed to operate cover a span of over 80 db. Low-noise tubes rarely have a maximum power output greater than 1 mw. Power tubes producing greater than 100 kw are in development. Figure 1C shows the transfer characteristic of the tube previously discussed. The shape of this curve is illustrative of the general transfer characteristic of any traveling-wave tube. A long linear range and a region of saturation is followed by a reduction in gain and power output. This characteristic makes the traveling-wave tube useful for a further group of applications since the saturation level may be set by the designer at any desired level.

The efficiency of the traveling-wave tube varies widely with its function. A low-noise tube may deliberately be operated at 1 percent efficiency, or less, while in power tubes beam efficiencies of 30 percent are obtainable.

If a traveling-wave tube is used as a low-level r-f amplifier, the noise generated in the tube must be considered. Two characteristic types of noise-figure designs are compared in Fig. 1D.

Modulation

Gain of a traveling wave tube is a function of tube current, making it relatively easy to obtain amplitude modulation. Some designs provide an element for that purpose. A typical grid-control characteristic is shown in Fig. 1E.

Total range of gain control available is from maximum gain to the cold loss of the tube, a range of 80 db or more. A third use of this characteristic is to provide a microwave pulsed signal of short duration. Rise and fall times approaching 1 millimicrosecond have been obtained in this fashion. Such a gate has a further advantage in that a klystron or other signal source may be operated c-w into the matched load of the traveling-wave tube with no resultant frequency pulling of the klystron.

Since the transmission line in which the traveling-wave tube gain occurs is electrically very long, for example 40 λ, a small change in the phase velocity can produce a sizable change in phase in the tube. This change in velocity can be accomplished by small variations in accelerating voltage. A typical characteristic is shown in Fig. 1F.

These characteristics make the traveling-wave tube an efficient modulator, since neither grid nor anode draw appreciable current. Single-sideband modulation can be produced by application of a sawtooth waveform to the accelerating anode. Such a waveform continually advances the phase, thus effectively shifting the frequency of the applied signal.

Limiter

If a traveling-wave tube whose saturation power level has been set at a desired power limit is used in a system, it becomes virtually impossible to exceed this level.

A traveling-wave tube preceding the crystal in a microwave receiver protects it from damage in both the operating and nonoperating conditions. The nonoperating protection results from the insertion loss of a nonoperating traveling-wave tube and is usually greater than 40 db.

Mixing

When two signals are applied simultaneously to a traveling-wave tube, several intermodulation components appear. When the tube is operating well below saturation, these components are at a low level. They are usually outside the frequency band of the tube and are further reduced in the coupling circuits. However, when the combined signal power is sufficient to drive the tube to saturation, the amplitudes of these components increase markedly. By appropriate design, tubes have been produced which function as r-f mixers. It is expected that further development of this technique will produce microwave mixes in which the local oscillator will be isolated from the antenna circuit by as much as 60 db of attenuation, the entire mixer will be essentially as broadband as normal traveling-wave tubes and it is expected that conversion gains can be realized.

It is relatively simple to use the traveling-wave tube in an oscillator circuit, if a small portion of the output power is fed back into the input of the tube. If a highly selective network such as a high-Q cavity, is placed in the feedback network, the frequency of oscillation will be determined by the cavity resonant frequency.

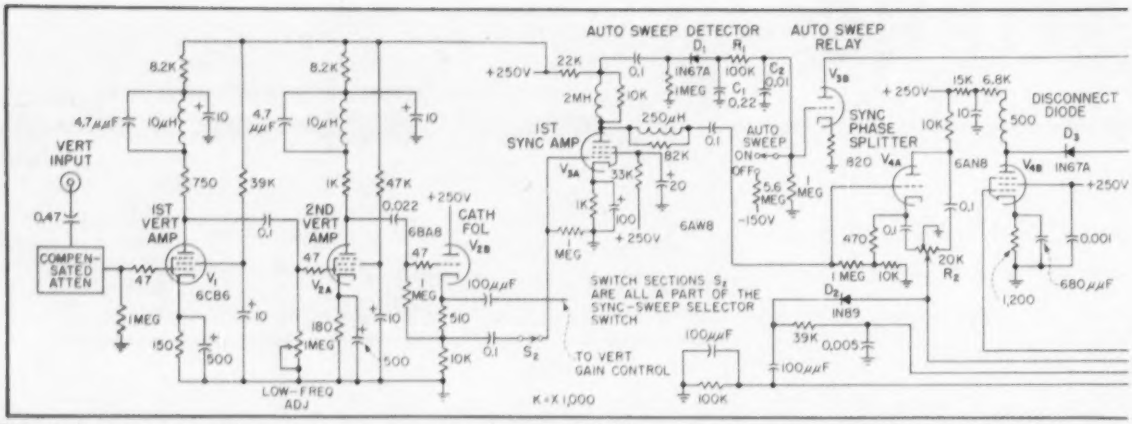


FIG. 1—Automatic triggered sweep circuit as used in Hycon model 622 oscilloscope, with conventional unmodified stages of

Signal-Triggered Sweep

SUMMARY — Automatic sweep control circuit for cathode-ray oscilloscope initiates horizontal sweep cycle for each pulse edge at vertical input terminals. Signal pulse display may then be expanded as desired by increasing sweep frequency, independently of pulse input frequency

By RUDOLPH L. KUEHN

Chief Development Engineer
Electronic Test Equipment Division
Hycon Manufacturing Co.
Pasadena, California

AUTOMATIC triggered sweep provides a recurrent waveform when no signal is applied to a cathode-ray oscilloscope, serving to establish a reference base line of the desired frequency and intensity. In the presence of vertical deflecting signals, the sweep circuitry assumes a monostable condition, responding thereafter to triggering signals derived from the display channel or applied from a related external source.

An oscilloscope circuit incorporating this sweep feature is shown in Fig. 1. In the absence of signal, automatic sweep relay tube V_{3B} is conducting and a relay closes the return circuit through R_5. The latter is internally adjusted to bias unsymmetrical multivibrator V_3 to an astable or recurrent mode. The period of the multivibrator is determined by selecting C_{12} or C_9 through C_{17}. Sweep range switch S_3 simultaneously selects the appropriate sawtooth-forming capacitor C_8 or C_9 through C_{17}. Pentode V_{3B} is held cut off by the gate supplied from the plate of V_{2A} through R_5. When the gate duration is terminated, V_{3B} conducts, discharging the sawtooth-forming capacitor and thus creating the retrace or flyback time.

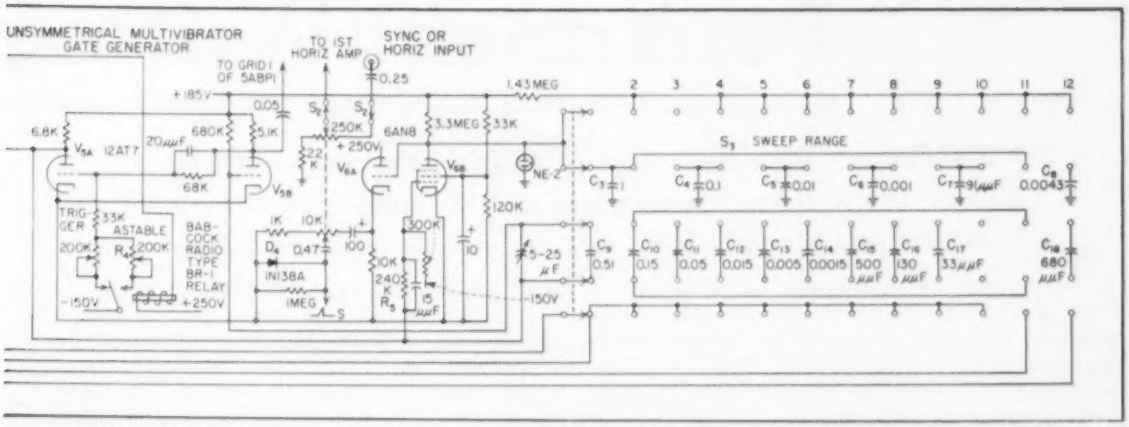
A signal present at the vertical input terminals of the oscilloscope passes through a compensated attenuator to first vertical amplifier V_1. From there it progresses to second vertical amplifier V_{2A} and cathode follower V_{2B}. The path to the vertical deflection plates of the cathode-ray tube continues from the cathode of V_{2B}.

Tapped down on the cathode of V_{2B}, a 0.1-μf capacitor connects the vertical input signal through SYNC-SWEEP selector switch S_2 to the grid of first sync amplifier V_{5A}. The frequency-compensated plate circuit of V_{5A} is connected through a 0.1-μf capacitor to the grid of sync phase splitter V_{4A}.

At the same time, the uncompensated portion of the signal is taken from the plate circuit of V_{2A} to AUTO SWEEP detector D_1. The latter, a germanium diode, develops a negative voltage across C_1 which is further filtered by R_1 and C_2.

The presence of signal in the vertical amplifier channel thus results in a negative bias being developed at the grid of V_{3B}, the AUTO SWEEP relay tube. With such bias present the tube current falls sufficently to make the relay drop out. In this condition the sweep gate generator return circuit is transferred to a 200K preset control which is adjusted to keep V_3 cut off or in a monostable condition. The operator function of readjusting a front-panel sweep stability or sweep sensitivity control is then eliminated by the circuit action just described.

To trigger gate generator V_3, now in a monostable mode, it is merely necessary to advance the single control R_2 in the desired polarity direction. The voltage, originating from the vertical channel, is applied through switch contacts of sweep range selector S_3 to the grid of V_{3B}. From the com-



scope circuit omitted for simplicity. Recurrent sweep is provided in absence of vertical signal to avoid burning screen

Magnifies Pulse Widths

pensated plate circuit of V_{5B} negative triggering pulses are applied to the gate generator through disconnect diode D_2 to complete the process.

The action of automatic sweep restoration is such that effectiveness has been measured with fractional-microsecond pulse widths at duty cycles as low as 0.2 percent.

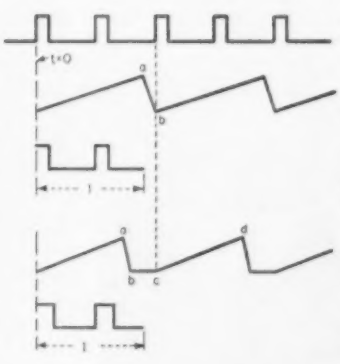
If the phenomenon to be observed is nonrecurrent and has too low an energy content to actuate the mode transfer of the sweep circuits, part of the waveform at the start of the trace may be missed or a stationary pattern may not be achieved. For such situations, front-panel AUTO SWEEP switch S_1 may be set to OFF. This places a fixed negative bias on the relay tube which keeps the gate generator permanently in a cut-off condition and ready for triggering.

The sync amplifiers are compensated in order that sufficient triggering voltage may be available to operate the instrument in the intended fashion with sine waves as high in frequency as 5 mc. Past this point the AUTO SWEEP will not switch to triggered mode, but stationary patterns are still obtained because the gate generator will synchronize when running recurrently. The vertical amplifier is down not more than 3 db at the 6-mc point.

The reference trace frequency is nominally the same as that of the triggered sweep. It is this unusual condition which allows synchronization of high-frequency sine waves which otherwise cannot actuate the automatic circuitry.

The power supplies of the instrument are electronically regulated, resulting in trace fluctuation immunity under varying line voltages and surges. A total of 3,000 volts between the cathode-ray tube gun and post-accelerator ensures adequate brightness even for P7 and P11 phosphors. The horizontal amplifier is balanced and d-c coupled, providing left-hand edge clamping of the trace. The cathode-ray tube unblanking voltage is also clamped, resulting in uniform beam intensity at low-frequency sweeps.

Oscilloscope incorporating triggered sweep



Conventional display of train of rectangular input pulses

Recurrent sawtooth sweep waveform used for above pattern

Appearance of resulting display for arbitrary pattern width *1*

Triggered sweep waveform; pulse edge initiates cycle at *c*

Triggered display, showing magnification of pulses

Comparison of triggered or driven sweep with synchronized free-running sweep

Permanent-Writing

SUMMARY —— Inertialess electron-beam recorder for writing directly on high-sensitivity electrographic paper uses 26 in-line targets swept by the beam of a modified cathode-ray tube. Targets are connected to external styli across which paper is pulled. System is unaffected by vibration

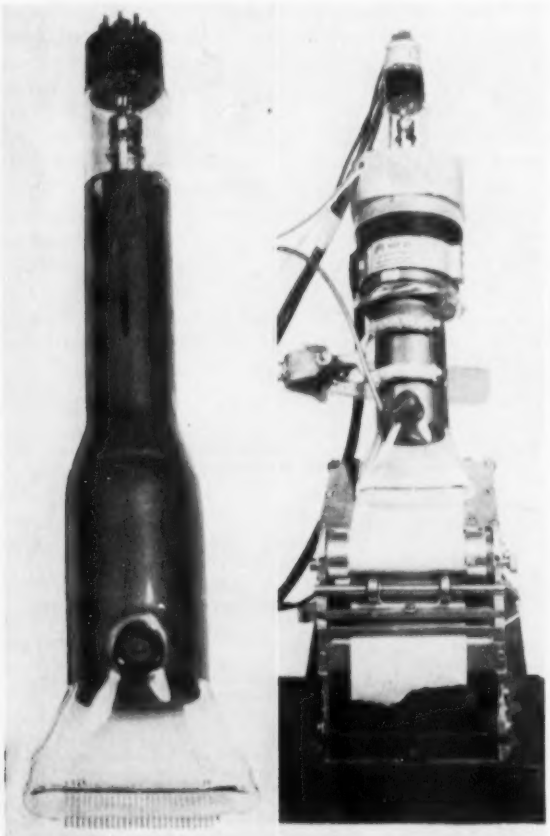
IN THE RECORDING system to be described, a virtually inertialess electron beam serves as the writing element for producing permanent markings on electrographic paper. The recorder resembles a modified cathode-ray tube, as shown in Fig. 1. At the upper end of the tube, coplanar closely spaced targets are sealed into the face of the tube, with the external portions serving as styli. Electrosensitive paper is drawn over the styli at constant speed in a direction perpendicular to the plane of the styli. Spring back-up fingers press the paper against the styli and serve as electrodes.

In operation, the signal to be recorded is used to deflect the electron beam in the plane of the elements. As the beam strikes each target in turn, the beam current passes through the face of the tube to the corresponding stylus. By the application of suitable potentials between the spring fingers and the cathode of the electron gun, this current is made to pass through the electrosensitive paper and produce a mark. The recording thus consists of a series of dashes, a continuous line through which constitutes a reasonable facsimile of the incoming signal.

A typical example of such a recording is shown in Fig. 2A, where a set of dashes may be seen, one for each stylus. The pattern is easily recognized as a sine wave.

Tube Construction

To simplify fabrication of the tube, the required number of targets is sealed into a press stem



Unmounted direct-writing cathode-ray tube and completely assembled recording system incorporating this tube

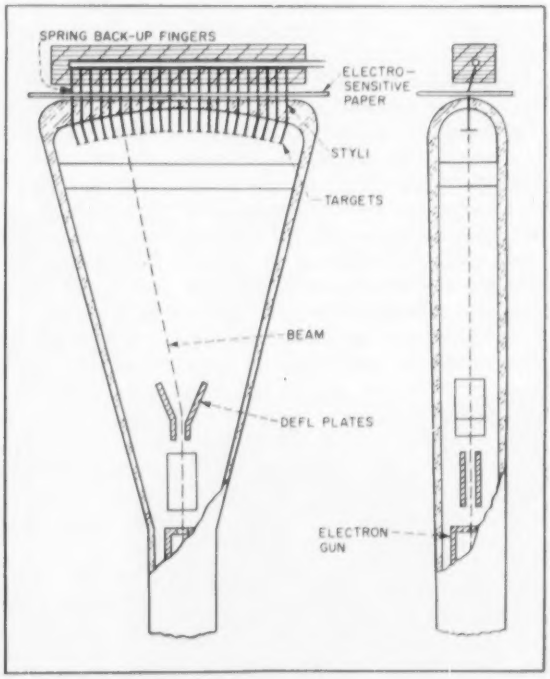


FIG. 1—Original concept of recorder tube, as shown by front and side views in patent application. Recording paper is pulled across face of tube by drive mechanism

Cathode-Ray Recorder

By LOUIS N. HEYNICK, ROBERT J. WOHL and DAVID H. ANDREWS

U. S. Naval Material Laboratory
Brooklyn, New York

mounted in place of the face. Since level recording was the primary application, 26 styli were uniformly spaced in a 2-inch row to give a range of 50 db in 2-db steps.

The tube styli can be used directly for writing, but it is usually more convenient to connect a set of external styli to the tube pins with a cable and plug. Deposition of a layer of phosphor on the glass areas adjacent to the targets aids in locating, centering and focusing the electron beam.

An electrographic paper developed recently by Naval Research Laboratory, having about 30 times the sensitivity of the best commercial papers available, yielded writing with the available beam current of the tube. However, the special paper required platinum styli held at a positive potential relative to the spring fingers. Electron flow was therefore in the direction opposite to that of the electron beam.

To provide a platinum writing surface, a piece of 20-mil platinum wire was bent into a U-shape and welded over each nickel stylus of the tube. The secondary electron yield from the targets proved sufficient to override the 0.5-ma primary beam and give the required reverse current.

Performance of System

Based on deflection over all 26 targets, sine-wave response is 11 cps, square-wave response is 500 cps and linear writing speed is 80 inches per second. The system limitation is the necessity for delivering sufficient charge to each stylus being swept by the signal to produce visible marking of the paper. For square waves, the beam need stay only on the initial and final targets about one millisecond, whereas for sine waves the beam must dwell on each intermediate target for at least this time interval. The sine-wave response limit is inversely proportional to the number of targets swept, whereas the square-wave response is independent of the number of targets swept.

The sine-wave response limit was verified at paper speeds of 25 and 125 mm per second, but at 5 mm per second the individual cycles of the input frequency merged into a continuous set of lines as shown in Fig. 2B. When the frequency is raised at this slow paper speed, the individual cycles become more closely spaced as in Fig. 2C and merge at around 11 cps. Each paper area under a given stylus then receives the charge from more than one beam traverse over the corresponding target before it leaves the stylus. Under these conditions the delivered charge is independent of frequency. As frequency goes up, the shorter dwell time of each beam traverse is compensated for by the corresponding increase in the number of traverses.

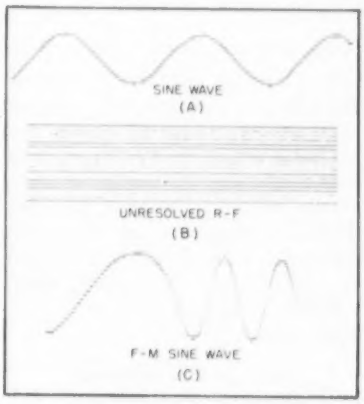


FIG. 2—Examples of traces obtained

The linear writing speed of the cathode-ray recorder is only about one-fifth that of the best commercial recorders. It has only 4-percent resolution, while that of commercial instruments is 2 percent. On the other hand, the square-wave response limit is about 5 times the upper limit of commercial recorders.

Larger writing currents can be obtained by using electron guns of greater current capabilities or by enhancing the secondary emission, or both. The frequency response will go up in direct proportion to the increase in writing current.

Other Applications

An in-line target tube may be used as a pulse-height analyzer, the voltage discrimination of which is fixed by the number of targets. Fast counters may be employed on selected pins to determine the incidence of the corresponding levels.

Another related application is as an analog-to-digital converter, wherein any arbitrary function may be chopped into its decimal equivalents. A third application is as a function transducer and recorder. External pins may be connected to the tube styli and spaced logarithmically or in any other manner along the width of the paper.

Acknowledgment is made to L. D. Chirillo of Boston Naval Shipyard for the original conception of this type of direct recorder tube, to Naval Research Laboratory for furnishing samples of their electrosensitive paper, to S. M. Sterling and J. P. Attard of the Electron Physics Section of the Material Laboratory for fabrication of the recorder tube, and to R. Winfield and N. Burton of the Cathode Ray, Storage and Phototube Section of the Material Laboratory for evaluation of the system.

The opinions or assertions herein are those of the authors and are not to be construed as reflecting the views of the Department of the Navy or the Naval Service at large.

BIBLIOGRAPHY

R. B. Loucks, High-Speed Direct-Trace Recording Methods, *Instruments*, p 30, Jan. 1951.

Balanced-Capacitance

SUMMARY —— Fence surrounding power plant, radar station or atomic energy installation is protected automatically against intrusion, minimizing size of costly four-shift guard patrols, by fail-safe electronic system that detects movement of person up to 7 feet away from antenna wires

By GLENN H. BROWNING

Chairman of the Board
Browning Laboratories, Inc.
Winchester, Mass.

TO SUPPLEMENT the protection provided by barbed-wire fences around electric power generating plants and substations, an electronic system was devised that set off an alarm when anyone approached or touched the barbed wire. This alarm system was so fool-proof that even if the details of its operation were known, it could not be penetrated.

The field of protection even extends into the ground below the fence to some extent, depending on soil conductivity, to detect anyone attempting to tunnel under.

The system corrects for capacitance changes automatically to correct for drift due to changing weather conditions, but at a sufficiently slow rate that it is practically impossible to penetrate by crawling slowly toward the fence antenna. Close to the fence, the slightest movement of a person's body trips the alarm. System sensitivity remains constant at all times, despite changes in antenna capacitance. Changes in antenna loss due to growth of weeds, rain on the wood antenna posts or damp insulation are of no consequence unless extreme, because two separate antennas are used and are connected to oscillators rather than to a tuned receiving circuit whose selectivity depends directly on antenna losses.

Design Experiments

A beat-frequency oscillator system was decided on because of the electrical leverage obtainable when employing beats between harmonics of the oscillators. An unbalanced system of wires was constructed outside the fence and capacitance measurements made at about 100 kc. It was found that capacitance changes of 50 $\mu\mu$f in a total of 2,000 $\mu\mu$f took place at sundown too rapidly to compensate for and still make the alarm effective.

A balanced system of wires extending in either direction from the end equipment was then tried. Measurements showed that the differential capacitance change was only a fraction of a $\mu\mu$f in 5,000 $\mu\mu$f. Inductive interference did not affect the end equipment when the oscillator frequency was in the 50 to 150 kc range.

Practical System

The final design, shown in Fig. 1, employs two oscillators, with the lines along the fence serving as part of the tuning capacitance of each oscillator. A mixer produces beats between the harmonics of the two oscillators. A frequency-selective network in the low audio range provides d-c voltages which are used as a bias for sharp-cutoff relay

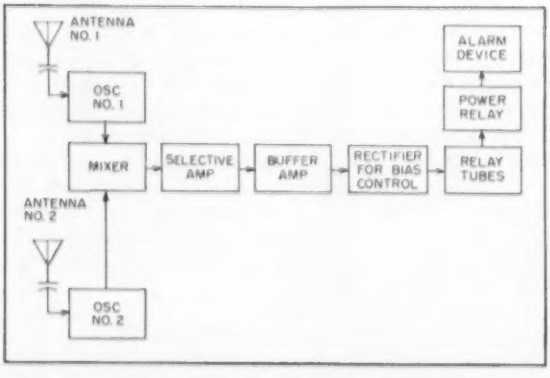


FIG. 1—Elements of complete electrostatic intrusion alarm

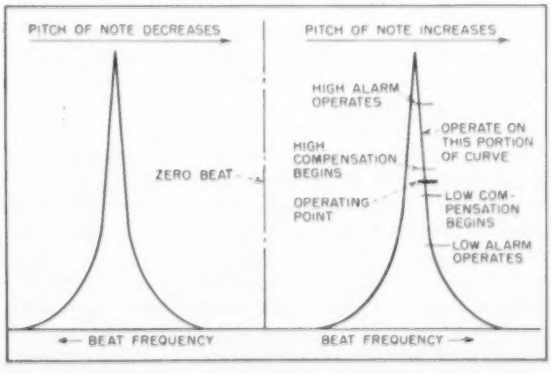
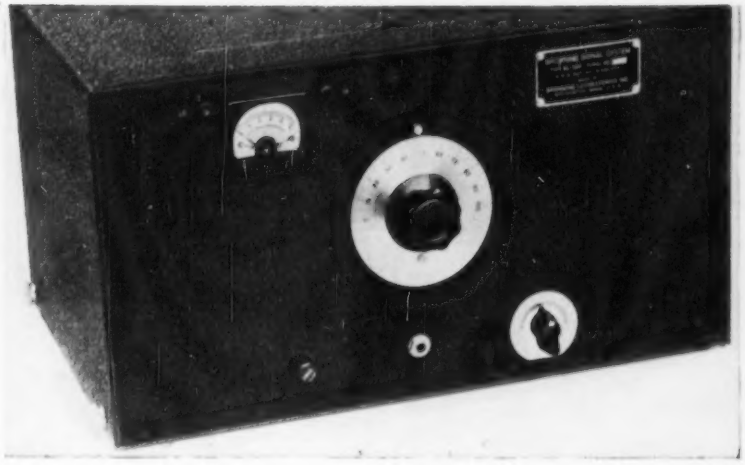
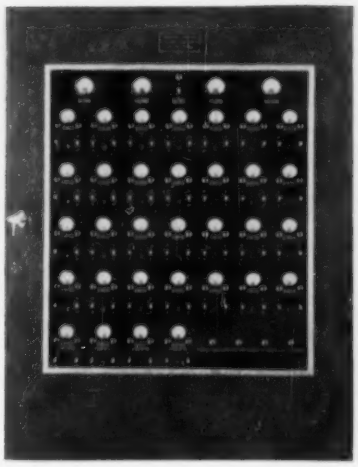


FIG. 2—Curves used for slow differential corrective system

FENCE ALARM SYSTEM



Front view of control unit, showing tuning dials, tuning meter and phone jack



Typical panel used at guard station

tubes that actuate the alarm through a power relay.

The inductances of the two oscillators are so proportioned that equal capacitance changes on the two halves will be balanced when employing harmonics of the oscillators. If the third harmonic of one oscillator is to beat against the fourth harmonic of the other oscillator and an equal capacitance change takes place on both oscillators, the resulting beat between the two must remain constant. Thus if $3f_1 = 4f_2$ and $C_1 = C_2$, then

$$\frac{f_1}{f_2} = \sqrt{\frac{L_2C_2}{L_1C_1}} = \sqrt{\frac{L_2}{L_1}}$$

$$\frac{L_2}{L_1} = \frac{16}{9} = 1.78$$

where f_1 and f_2 are the frequencies of the oscillators and L_1, C_1, L_2 and C_2 are the inductances and capacitances in the tuned circuits.

Thus, the required inductance of one oscillator must change according to the harmonics employed. Harmonic operation of the oscillators is essential.

If the selective network is so designed that maximum response comes at 500 cycles, then $500 = N_1f_1 - N_2f_2$, where N_1 and N_2 are the harmonics used. If f_1 and f_2 are large, a small percentage change in either will produce a large percentage change in the beat note. Under typical operation $N_1 = 3$, $N_2 = 4$, $f_1 = 100{,}000$ and $f_2 = 74{,}875$. Now if f_1 should increase to 100,010 cycles (an increase of 0.01 percent), the beat note will increase to 530 cycles (6 percent or 600 times the percentage increase in f_1). It is this electronic leverage which gives the system its sensitivity.

Drift Correction

The balanced system shown in Fig. 1 performed well over areas where the ground soil was about the same, but when one half of the antenna was run over swamp and the other half was over sandy soil (an extreme case) the capacitance change on the two halves was far from equal. A slow differential corrective system was therefore added. This served to determine whether the capacitance on one oscillator should be increased or decreased, and provided control circuits to start and stop capacitance correction.

By operating on the side of the selective cusp, the required sense indicator is obtained as shown in Fig. 2. The increasing or decreasing rectified current makes the control circuit increase or decrease the capacitance of one oscillator to bring the system back to balance at the operating point as indicated. Working on one side of the selective circuit requires an additional alarm tube and associated relay.

The method employed for differential correction, shown in Fig. 3, uses a variable capacitor connected to one oscillator and driven by a reversible Telechron motor which in turn receives its power from four thyratrons. Two of these thyratrons get their control bias from diodes which are adjustable so that compensation can be started at a desired point. The other two thyratrons are connected inverted and fired by a network from the control thyratron, thus operating the motor. One thyratron of the type used had insufficient power to drive the motor.

Adjustable controls permit setting the operating point as well as the high alarm, high compensation and low compensation at the required point on the selective curve shown in Fig. 2.

An alarm must be given should any tube or component in the end equipment fail. Thus, the low-alarm relay is energized under normal operation and drops out when in alarm condition. The filament of the high-alarm thyratron is placed in series with the 6N7 low-alarm tube so that the low-alarm relay will drop out should the high alarm be inactive.

With a two-wire antenna system

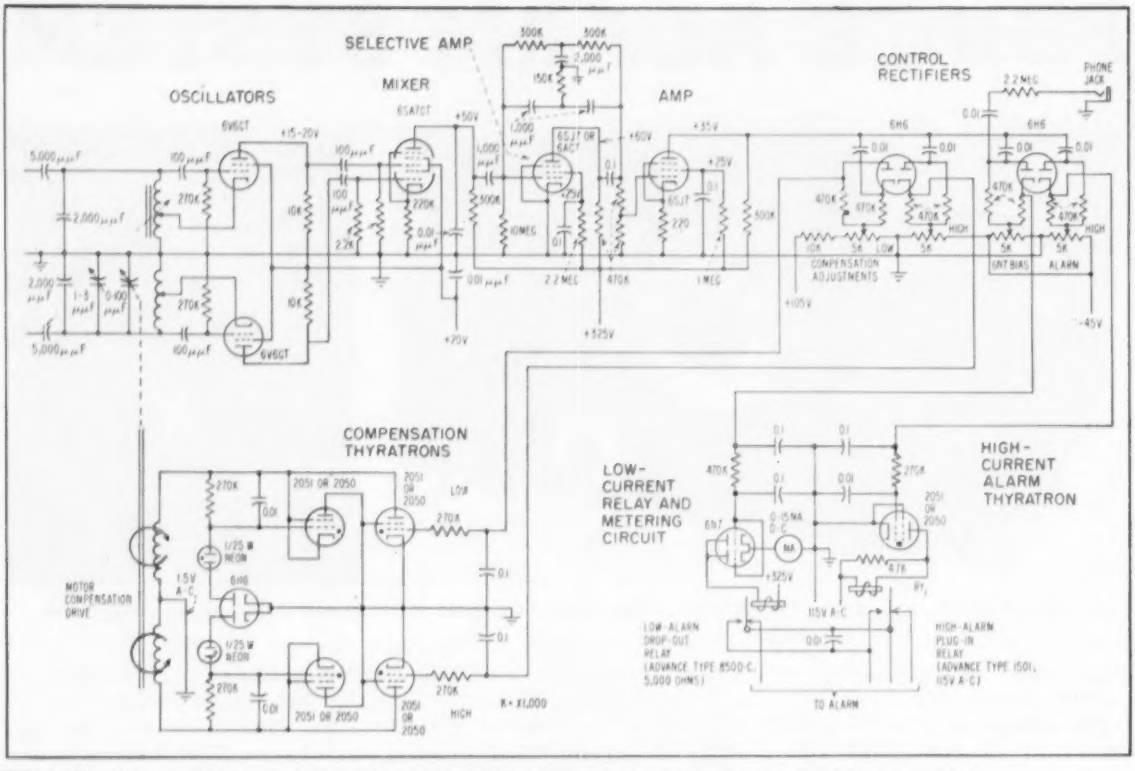


FIG. 3—Complete control circuits of Browning model BL-300 alarm signal system. Power supply is conventional

using insulated wires 2 and 4 feet from the ground on metal supports close to the barbed wire fence, false alarms were common. The capacitance of the antennas was changed by the wind swaying the barbed wire. Rain changed the capacitance materially. Rain drops would collect on the antenna wires and when a gust of wind blew them off, a false alarm resulted. The rain also changed the capacitance to the metal arms supporting the antennas.

When the antennas were placed about 3 feet from the fence, the trouble from the wind on the fence was eliminated and the apparent sensitivity was greatly increased. With 1-$\mu\mu$f equipment sensitivity, the detection range of a person was about 1 foot when the antennas were close to the fence, but with the antennas 3 feet from the fence a person was detected about 4 feet away.

Changing to a powdered mica insulating covering for the antenna wire allowed practically no moisture droplets to collect, but rain still gave false alarms. When porcelain insulators on wooden arms were used to support the antenna wires, the trouble with rain disappeared.

The final antenna layout is shown in Fig. 4. It consists of a three-wire system. The lower wire is 18 inches from the ground, the second is 2 feet and the third is about 6 inches below the top of the fence. Detection range is up to 7 feet, depending on the sensitivity setting. Each control unit covers 500 linear feet (250 feet each half) and is on guard night and day, reducing manpower requirements for guards to a minimum. So far as is known, this system has never been penetrated without sounding an alarm.

The system is essentially insusceptible to external jamming, as the selective circuit is well isolated from the antenna circuit. Plug-in selective circuits of different operating frequencies could be used for even greater difficulty in jamming, by giving three unknowns—the two harmonics and the frequency of the selective circuit.

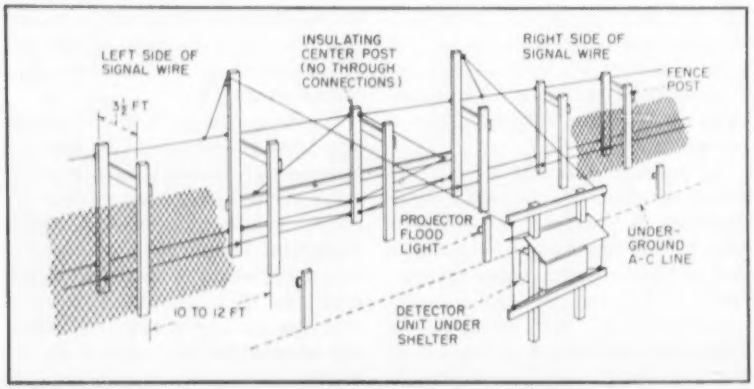


FIG. 4—Example of antenna system and lead-in for woven-wire fence

Systems Development

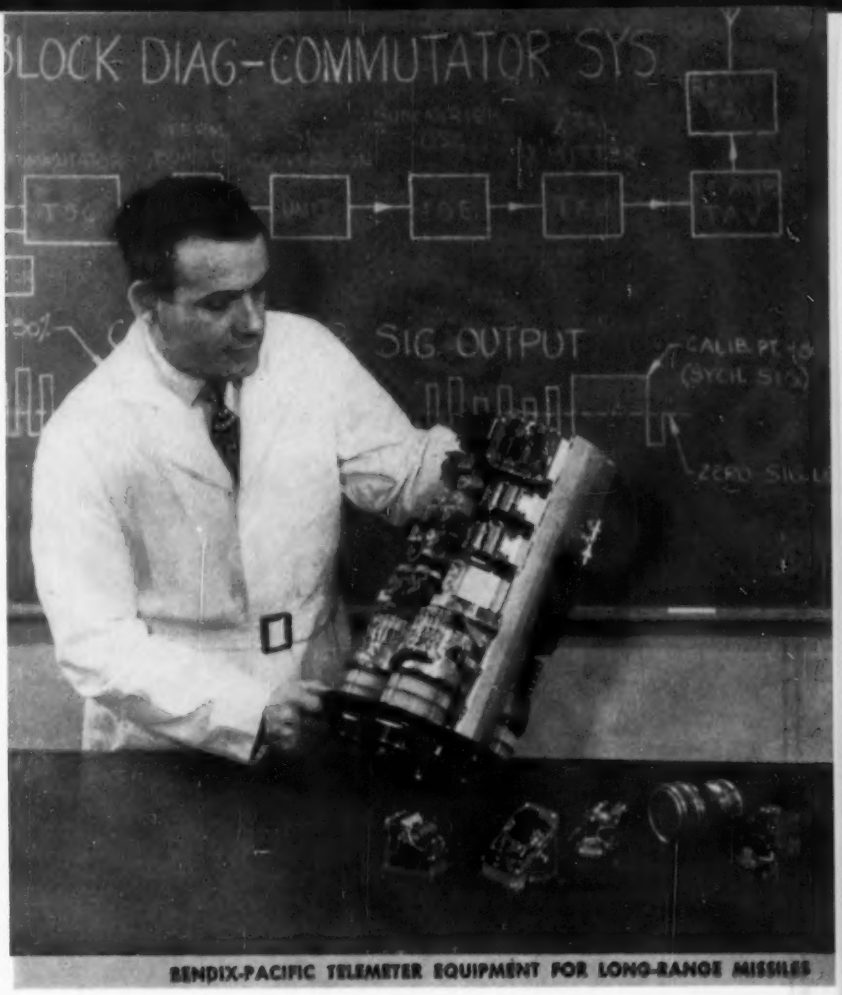
Input Transducers

Signaling Methods

Commutating Devices

Output Indicators

and Bibliography



BENDIX-PACIFIC TELEMETER EQUIPMENT FOR LONG-RANGE MISSILES

Telemetering

Electronic Data Transmission

By ALEXANDER A. McKENZIE *Associate Editor*

and HAIG A. MANOOGIAN *Assistant Editor*

An **electronics** Special Report

APRIL • 1956

©McGraw-Hill Publishing Company

TRANSMISSION of information, or data, plays an increasingly important role in man's conquest of his environment. The development of means for transmitting data is as significant to modern technology as was the formulation of spoken, or written, language to earlier progress.

The summary represented by this Special Report describes a number of the more frequently used techniques for transmitting data from one place to a distant point. There are others that cannot be treated here and there are techniques as yet unexploited.

The measurements of science and the control of many industrial processes depend largely upon meter readings. It is natural that the reading of meters at a distance has become known as telemetering. In a broad sense, telemetering, or data transmission, includes not only meter readings but also comparable intelligence. Sometimes, for example, it is more profitable to study the integration of a series of meter readings that have been printed upon a moving chart or photographed in sequential steps upon a film.

Keeping this survey within reasonable confines required that limits be set. Telemetering is generally defined as the indicating, recording or integrating of a quantity at a distance by electrical translating means. The main emphasis here is upon electronic data transmission. Examples are drawn from many branches of electronics, but communications, remote control and automation as such are not the subject of discussion

AFTER TAKE-OFF

REGULUS guided missile shown at right (and on the front cover of the April 1956 issue of ELECTRONICS) was developed by Chance Vought Aircraft, Inc., under sponsorship of Navy Bureau of Aeronautics. It may be launched from submarines, surface ships and shore bases. Many of these missiles equipped with tricycle landing gear and parachute-type brake have been recovered and used for further data gathering flights

Systems Development

Telemetering systems have grown with need. An early application, over existing wires, aided in the distribution of electric power. Later, scientific exploration of the atmosphere made radio transmission necessary. Today, the demands of business, industry and defense make telemetering of many kinds mandatory

PATENTS issued in 1885 in the United States described electrical telemetering systems. It was not until 1912, however, that a Chicago public utility installed a system that was employed to aid in load dispatching.

In the years since, power-line telemetering systems have become available in standard packages. Equipment used for the measurement and control of temperature has likewise become available. There are, as well, commercial systems for measurement of fluid flow and many other parameters.

In the mid-thirties, particularly with increased use of radio frequencies above 50 mc, great interest developed in exploring and investigating phenomena of the upper atmosphere. Weather and cosmic ray data began to be accumulated using balloon-supported radio transmitters. This interest resulted from the findings of the Second International Polar Year, 1932-33. Plans for the International Geophysical Year (IGY) call for further sounding the nature of the atmosphere and the region above it during 1957-58.

During the early forties, there was accelerated interest in systems for broadcasting position data, particularly to military ships and aircraft. Detection systems, such as radar and sonar, that would give evidence of enemy presence were in demand.

Automatic control of antiaircraft armament brought a further need for data that was answered to some extent by iff (identification, friend or foe) equipment that kept most friendly planes from being shot down.

The war that had spurred these interests came to an end before the Germans could produce and launch any quantity of guided missiles in which they had specialized their research. United States forces used some remotely controlled drones loaded with explosives, as well as devices equipped with television transmitters.

As a result of continued research the art of hurling equipment high into the atmosphere has now reached a point at which it is possible to envision the use of an intercontinental ballistics missile (ICBM). Telemetering equipment to test such a missile is shown on the cover of this Special Report.

The need to know what is happening to a missile under test has opened a whole new field of telemetering. Because of the tremendous activity here, standards were set up for certain aspects of missile telemetering. While these standards (reproduced here) have been outgrown, they are still used where possible.

The field of telemetering is growing. During 1957-58 some dozen earth satellites will be separately launched by the United States. Each one is expected to circle the earth about once every 90 minutes and remain in orbit a matter of days or weeks. New telemetering devices will turn on the satellite transmitter briefly while it sends down scientific data from overhead.

System Principles. Although data transmission systems are generally complex, they can often be divided into simpler component parts. The development of an industrial or power-line type of telemetering system is shown

Table I—Teleprinter Codes

UPPER CASE			LOWER	5-UNIT					7-UNIT						
WEATHER	ARMY PRIVATE	RCA	CASE	1	2	3	4	5	1	2	3	4	5	6	7
↑	—	—	A	•	•				•		•	•			
⊕	?	?	B	•			•	•		•	•				•
○	,	:	C		•	•	•		•				•	•	
↗	$	$	D	•			•		•			•	•		
3	3	3	E	•								•	•	•	
→	!	!	F	•		•	•		•				•		
↘	&	&	G		•		•	•						•	•
↓	⁄	#	H			•		•		•				•	•
8	8	8	I		•	•				•		•	•		
↙	'	BELL	J	•	•		•				•		•	•	
←	(	(	K	•	•	•	•					•	•		•
↖	)	)	L		•			•		•	•			•	
·	·	·	M			•	•	•	•		•		•		
ⓓ	·	·	N			•	•			•	•		•		
9	9	9	O				•	•	•	•		•			
0	0	0	P		•	•		•		•		•		•	
1	1	1	Q	•	•	•		•		•				•	•
4	4	4	R		•		•				•	•		•	
BELL	BELL	'	S	•		•					•			•	•
5	5	5	T					•	•	•			•		
7	7	7	U	•	•	•			•	•				•	
ⓘ	;	;	V		•	•	•	•			•	•			•
2	2	2	W	•	•			•	•	•					•
/	/	/	X	•		•	•	•				•		•	•
6	6	6	Y	•		•		•	•		•			•	
+	"	"	Z	•				•	•					•	•
SPACE						•			•	•	•				
LETTERS				•	•	•	•	•		•	•	•			
FIGURES				•	•		•	•			•	•	•		
CARRIAGE RETURN							•		•		•				•
LINE FEED					•				•			•			•

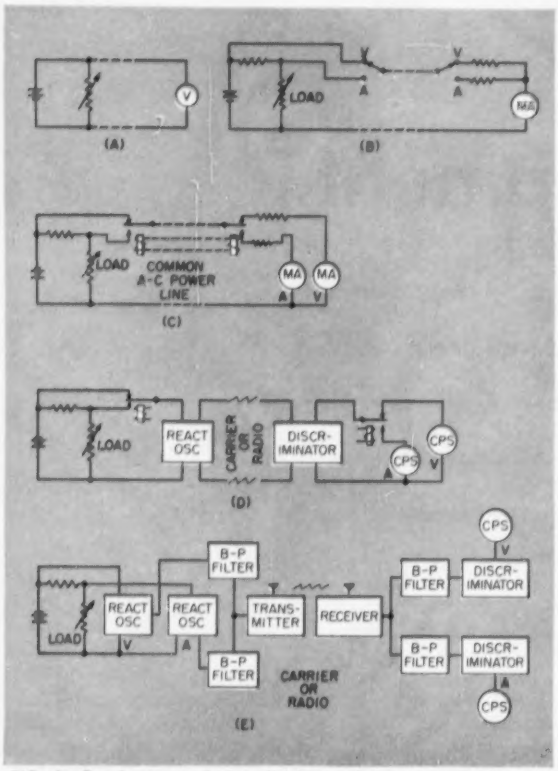


FIG. 1—Development of time-division and frequency-division telemetering systems. Means of computing power at a distance using wire line, radio or carrier is shown

in Fig. 1. At (A) is shown a battery and load. The voltmeter, whether it be viewed at the load or some distance away (assuming the resistance of the line be compensated) reads the potential across the resistance.

If a resistor is placed in series with the variable load, as at (B), there is means for determining the power absorbed in the load through measurement of voltage and current. The resistors in series with the milliammeter allow compensation for line resistance.

Although it is necessary to have someone throw the switch from V to A according to a prearranged plan in order to meter at a distance, this is not so if the sampling system at (C) is used. Assuming a conventional a-c power line, the switching is automatic. (Such synchronization is common in other telemetering systems like facsimile and teleprinting.) Dwell time of the relay contacts must be considered in adjusting the meter resistors.

A carrier-current can be superimposed upon the connecting line, or a radio circuit can be used to tie together the transmitting and receiving locations. At (D) is shown a simplified reactance oscillator, the frequency of which is varied by the input d-c. Voltage and current indications at the receiver are given by frequency-sensitive devices that sample the output of the discriminator.

The system shown in Fig. 1E operates on a frequency multiplex basis without sampling. Here two separate reactance oscillators are controlled over an adequate frequency band and then output signals are combined in a radio or carrier transmitter. At the receiver, filtered signals from the output pass separately through discriminators to indicating meters.

Simple System. The distance between transmitter and receiver need not be great to qualify a telemetering system.

An example is the device shown in Fig. 2. It comprises a couple of bimetal units, one of which opens a normally closed electrical contact. The other controls the position of a pointer.

The measuring element can be moved, as by float in a tank of liquid, and it then controls the length of time that the contact is maintained. The longer the receiver bimetal is heated the higher the pointer rises on the scale. Thermal inertia bucks out sudden fluctuations, as might occur in the gasoline tank of a moving vehicle.

Radiosondes. Although balloon-supported radiometeorographs were used in several countries prior to 1930, significant American developments stem from the mid-thirties. The radiosonde, as it became known, was arrived at through necessity. During periods of worst weather when meteorological information is most desired it is unfeasible to fly kites or send aircraft aloft. Probably more thousands of weather telemeters have been manufactured and used than any other one data transmitting equipment.

American radiosondes in present use employ a sampling system to send back data. An early type used the Olland principle that gave a weighted sample unlike the signal from a simple commutator device. As shown in Fig. 3 the meteorograph elements comprise a hair hygrometer, bimetallic thermometer and aneroid cell. To these are attached contact arms that bear upon the surface of a disk rotated by clockwork. A reference mark gives a fixed time mark against which the other elements are measured, because the clockwork is affected by temperature. An idealized chart is shown at the right indicating changes in pressure, temperature and relative humidity.

The circuit used in developmental models built at Blue Hill Observatory employed an oscillator that sent out impulses of modulated carrier when the meteorograph made contact. Modulated plate voltage was provided by a buzzer transformer. Carrier frequency was near 60 mc. Output from a super-regenerative receiver was connected to a magnetically operated pen bearing against a rotating drum to which the chart was fastened. A modern version of the radiosonde is described in the section on commutation, where it is used to illustrate a means for plotting one function against another.

Cosmic Ray Counting. The direction of arrival of cosmic rays upon the surface of the earth depends upon geomagnetism. The number of particles increases with elevation above sea level. Because these facts were known only qualitatively around 1935, a few investigators began a program of balloon ascensions. These experiments have

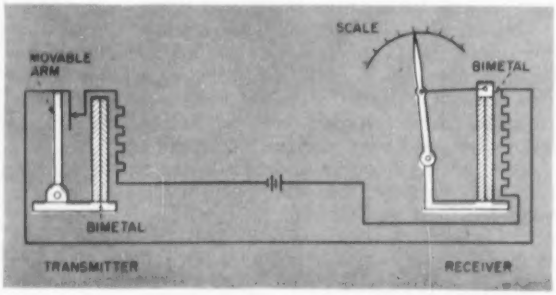


FIG. 2—Simple telemeter that depends upon the heating of bimetallic strips. Position of the movable arm determines height on scale to which pointer will rise

been supplemented since the war by telemetering rockets and will be further pursued during the International Geophysical Year.

One model of cosmic-ray sounding equipment used successfully during 1936 and 1937 employed an escapement switch. Two kinds of information were time-multiplexed: altitude and the number of vertical cosmic rays. The escapement allowed the equipment to fall gradually away from the balloons that carried it aloft.

Elements of Telemetering. The essential portions of a data transmission system include a transducer, sometimes called a pickup, or sensing device, to change some other form of energy into electrical energy, a transmission or signaling system and a receiver with an output transducer or recorder.

If it is desired to transmit information from a number of pickups, there are two possible ways to perform the function. Either more simultaneous channels of transmission must be provided or data from a number of pickups must be sampled in sequence and properly identified at the receiver. Sometimes both methods are used at once.

A number of present and proposed telemetering systems are indicated in the dot chart, Table II.

Military Applications. Missile data transmission systems during the war were generally confined to guidance functions. The only German system known to have seen service is the Strassberg-Kehl command link.

Shown in Fig. 4 is the modulated data transmitter (A) into which two pairs of audio frequencies are fed through the control that is actuated like the joystick of an airplane. With the control in a neutral position, a rotating commutator feeds equal periods of each frequency through movable brushes to the modulator.

Moving the control in any direction causes one frequency in either or both of the low and high-frequency oscillator pairs to predominate. This effect is illustrated in (B) where the normal and downward signals of the up-down channel are blocked out on the basis of time. In the downward position, the 1-kc signal predominates.

In a guided aircraft equipped with the receiving devices shown in (C) the control surfaces are continually vibrating. Change occurs when the control is caused to spend more time on one side than the other of its neutral position.

Since the commutator at the transmitter rotates at 5 rps, it sends out alternate 1/10-second pulses from each half of each pair of oscillators.

Other Telemeters. Many types of telemeters have similarities to those already described. Some of them are data systems—others fringe upon control as well, such as chart recorders in which the off-zero position of an associated potentiometer can supply a control voltage.

Another type of telemeter equipment is the teletypewriter, for which codes are shown in Table I. Although teleprinter equipment used for communications is standardized, its output can be encoded and its input signal decoded.

The teleprinter has been used as a computer output device. Although it is customarily equipped with letters and numbers, these may be essentially meaningless in certain telemetering applications in which provision of a different keyboard and type keys convert impulses to symbols. This, in fact, is true for weather map symbols.

Propagation-affected Data. A data transmission system

Table II—Applications of Telemetering

	now	future
BUSINESS		
Accounting		○
Branch tie-in		○
Burglar alarms		○
Fire alarms		○
Inventory control		○
Space-reservation	●	
Stock ticker	●	
Telautograph	●	
Teleprinter	●	
COMMUNICATIONS		
Automatic teleprinter correction	●	
Broadcast remote control	●	
Telecasting remote control		○
Wire data circuits		○
INDUSTRIAL		
Data for automatic control		○
Fluid depth measurement	●	
Measuring gas flow	●	
Pipe-line control	●	
Rainfall reporting	●	
Reading gages by tv	●	
MILITARY		
Battleground television		○
Doppler devices	●	
ICBM		○
Personnel data	●	
Radioactive monitoring		○
SAGE	●	
Search-Rescue operations		○
Sonobuoy	●	
Target drone aircraft	●	
TV-guided missiles	●	
Ultrafax		○
Underwater detection nets		○
RESEARCH		
Aircraft design	●	
Flight testing	●	
Landing on planets		○
Medical research	●	
Missiles	●	
Navigation-data sendback		○
Nuclear experimentation	●	
Projectiles	●	
Radiosondes	●	
Satellites		○
TRANSPORTATION		
Automatic flight plans		○
Automatic railroading		○
Hyperbolic navigation	●	
Radar speed detection	●	
Radar traffic detection		○
Rho-theta navigation	●	
Train identification	●	

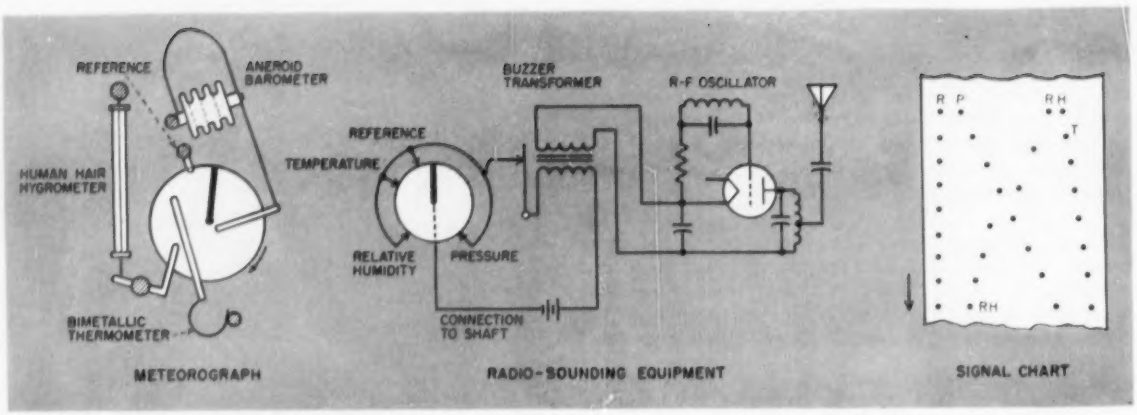


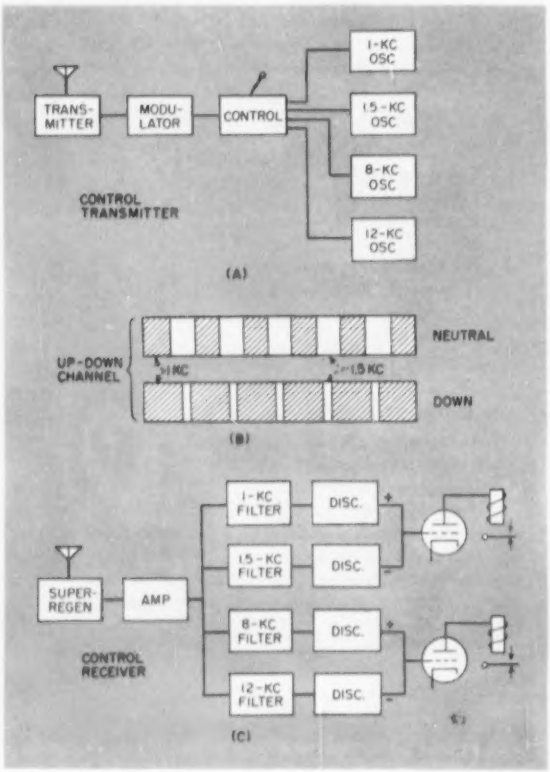
FIG. 3—Elements of a radiosonde based upon the Olland sampling principle. Relative displacement of elements is shown by a series of short dashes on moving chart paper at ground station

that receives increasingly wider use is one in which the finite delays in the propagation of radio waves from a pair of suitably synchronized radio transmitters is used to plot a line of position. Two properly disposed pairs of transmitters provide a fix. A fix can likewise be obtained from so-called rho-theta systems, but usually the distance between master and slave transmitters would be less than 200 miles.

A simplified hyperbolic line of position intersecting a second is shown in Fig. 5A. Such a diagram is basic to navigation data systems like Gee, loran, Lorac, Raydist and Decca. It suggests possibilities of moderately long-range missile guidance in which a single line of position is used to take the missile to its target where it is dumped, either by impulse from an intersecting line or by some other means.

Relayed Fixes. Of peacetime interest for purposes of sea rescue is the automatic relay of hyperbolic data. Equipment requires only the operation of a switch by any occupant of a lifeboat. Line-of-position data that would ordinarily be read off by a navigator can be used to modulate a pulse transmitter. These pulses, together with other identifying codes, would be picked up at one or more receiving stations.

Only one line of position is shown in Fig. 5B for simplicity. In actuality, pulse signals giving line-of-position data from two pairs of navigation-aid stations would be alternated. Such information would be much more exact and definite than the bearings of even the best conventional direction-finding equipment. At least one relayed-fix system of this general type is under development in the guided missile program.



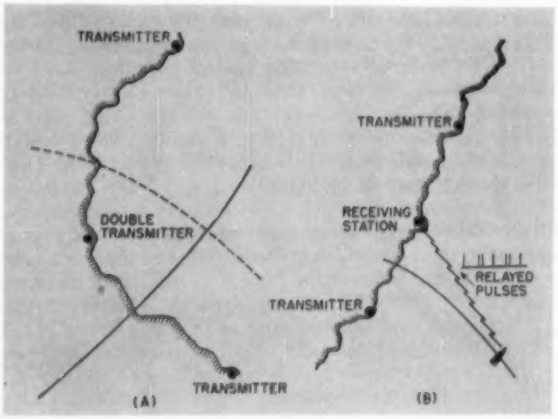


FIG. 5—Data transmission in position-finding system often depends upon time of propagation. A standard hyperbolic fix from two pairs of transmitters is shown at (A). A relayed line of position comes from the lifeboat at (B)

FIG. 4—Strassberg-Kehl command (left) was used by the Germans for remote radio guidance of missiles. Employing two pairs of audio tones, it vibrates control surfaces more to one side than to the other for guidance

Input Transducers

Transducers, or pickups, are important links in a telemetering chain. These devices transform the energy of the measurand—the physical quantity, property or condition to be measured—into another form of energy such as an electrical current or voltage

In choosing a transducer for a particular application, factors such as hysteresis error, resolution, frequency response, sensitivity, calibration, repeatability and compatibility are considered.

Compatibility of a transducer must be considered from two aspects, mechanical and electrical. Mechanical compatibility encompasses environmental conditions such as vibration, temperature, pressure, atmosphere, space limitations and mounting arrangements.

Electrical Compatibility. If a commercial telemetering system is to be used, the transducers must be electrically compatible with the other equipment of the system. In conventional frequency-division-multiplex systems, the f-m subcarrier oscillators may be modulated in any of three ways, as variable-voltage, variable-resistance or variable-inductance controlled oscillators.

Most voltage-controlled f-m subcarrier oscillators have been standardized to produce a ±7.5-kc subcarrier frequency deviation from an input of 0 to 5 volts.

Manufacturers of time-division-multiplex systems have adopted both a 0 to 5-v and a 0 to 5-mv standard. The 0 to 5-v standard was recommended for pwm telemetering by the Research and Development Board.

Consideration must be given to transducer sensitivity. In an f-m multiplexing system, excessive transducer output can cause the associated subcarrier oscillator to be driven into an adjacent channel, thereby causing interference. Transducer sensitivity is consequently not higher than actually needed for an application.

Resistive Transducers. Potentiometer, strain gage and nonmechanical-resistance-variation devices are three major types of resistive transducers.

In the potentiometer type, a change in resistance is obtained by causing a linear or rotary motion to displace the wiper arm. In most applications, the potentiometer is connected across the voltage source, as shown in Fig. 6, and the variable output voltage used directly to modulate an a-m or f-m subcarrier oscillator. It is also connected as a rheostat in the frequency-determining circuit of an oscillator, providing an f-m subcarrier signal.

One of the potentiometer transducer's advantages is the comparatively high output voltage available, depending on the voltage source, making it possible to reduce or eliminate subsequent amplification and accompanying deficiencies. Other favorable factors are that precision devices will provide readings in voltage ratio versus measurand with errors of the order of tenths of a percent; wear, of the order of a million cycles, will cause little change in the initial error. If the supply voltage is transmitted as a reference, output accuracy is not affected by changes in supply voltage or temperature since the output is in the form of a ratio.

Limitations. Accuracy of these devices is limited by geometric precision and improves with the length of the wound element. Sensitivity or resolution of a potentiom-

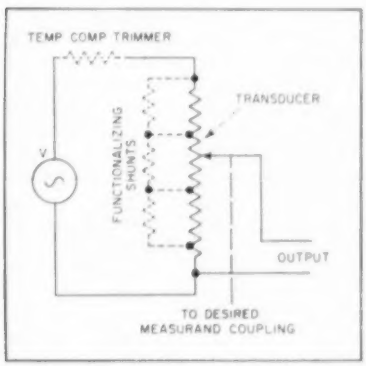


FIG. 6—Typical potentiometer-transducer circuitry. Dashed-line components may be added as needed

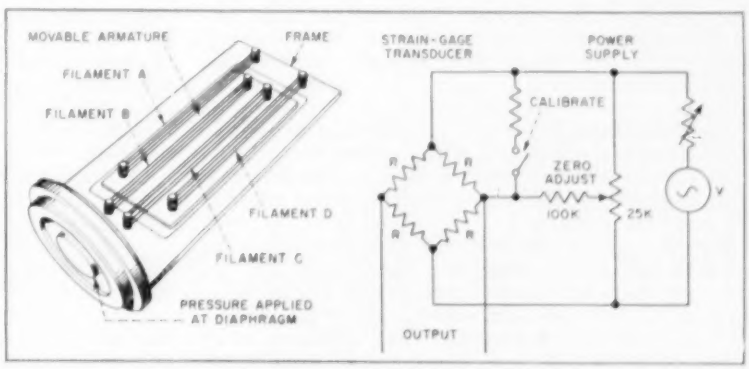


FIG. 7—Unbonded strain-gage pressure transducer has diaphragm mechanically coupled to movable armature. Pressure variations cause armature to move and change tension of wire filaments. Typical circuit is shown at right; source voltage can be a-c or d-c

Table III—Characteristics of Accelerometers

	Potentiometer	Variable Reluctance	Differential Transformer	Piezoelectric	Variable Capacitance	Strain Gage	EMF Generating
Acceleration Amplitude (1/sec)	1 to 50	1 to 200	1 to 200	0.1 to 30,000	1 to 200	1 to 1,000	up to 100
Highest Resonant Frequency (cps)	90	500	500	80,000	50,000	2,000	5
Useful Freq Range	0 to 50	0 to 350	0 to 350	3 to 25,000	0 to 25,000	0 to 1,500	5 to 2,000
Self-Generating	no	no	no	yes	no	no	yes
Damping	magnetic fluid	fluid	magnetic fluid	none fluid	none	fluid	magnetic
Excitation	d-c carrier	carrier	carrier	none	carrier	d-c carrier	none
Output Impedance	10,000 ohms resistive	1,000 ohms inductive	200 ohms resistive	1,000 $\mu\mu$f capacitive	50 $\mu\mu$f capacitive	600 ohms resistive	200 ohms resistive
Accessories	none	bridge	carrier	cathode follower	bridge	bridge	none
Upper Temp Range (without coolant)	350 F	350 F	350 F	500 F	500 F	250 F	500 F
Resolution	½ percent	limited only by design					
Accuracy	1 percent full-scale	1 percent full-scale	1 percent full-scale	1 percent full-scale	3 percent actual reading	1 percent full-scale	1 percent full-scale

eter is inversely proportional to the number of turns on the resistive element. Present techniques permit wiping as many as 1,500 turns, which is equivalent to a resolution of 0.067 percent. Another limitation is imposed by the frequency of the potentiometer wiper motion. Above approximately 10 cps, the wiper tends to bounce on the element surface.

Potentiometer transducers as shown in the photographs are often used to measure pressure and acceleration. The measurement of the accelerating force is obtained as a resistance or voltage ratio by having a spring-supported, magnetically or fluid damped mass move the wiper arm of the potentiometer in direct proportion to the value of acceleration. The characteristics of such accelerometers are shown in Table III.

Wire-Strain Gages. Probably the second most widely used type of resistive transducer is the resistance-wire strain gage. Operation of this device is based on the change of electrical resistance that occurs when the wires constituting a gage are stretched.

Bonded gages are made in the form of a continuous resistance-wire grid cemented to a carrier sheet. The carrier transfers strain to the wire through the cement. Gages are available with resistance values of 60 to 5,000 ohms. The basic gage has a resistance of about 120 ohms, which is large compared to the resistance of lead wires and switch contacts. Bonded gages are commonly applied to test structures for the measurement of stress-strain, torque and deflection.

The unbonded gage in its basic form is a displacement transducer. In the center of a stationary frame an armature is supported rigidly in the plane perpendicular to the longitudinal axis in such way as to allow free movement along this axis. Wound between rigid pins mounted in the frame and armature are four windings of strain-sensitive resistance wire which comprise the four elements of a Wheatstone bridge, as shown in Fig. 7.

As the armature is caused to move longitudinally by an external force, two sets of filaments are elongated and increase in resistance, while the other two sets shorten and decrease in resistance. The resistance change of the filaments alters the electrical balance of the bridge to produce an electric signal in the output circuit. When a bellows or diaphragm is attached to the linkage of the unbonded displacement transducer, the element becomes a pressure transducer. The basic element becomes an acceleration transducer when a mass is attached to the armature.

Unbonded gages have nominal bridge resistance of from 50 to 15,000 ohms. With 5 to 200 volts d-c or a-c input, they supply full-range open-circuit voltages from 10 millivolts to 1 volt and full-range currents of 30 to 400 microamperes. Unbonded gages are available which have an accuracy of 0.25 percent of full scale.

The stepless character of the output of bonded or unbonded gages makes their ultimate resolution limited only by the characteristics of the associated equipment.

Both bonded and unbonded gages may be used with either d-c or a-c bridge circuits. An a-m subcarrier may be obtained directly by exciting the bridge with the subcar-

rier frequency. The bridge output may also be used to modulate an a-m or f-m subcarrier oscillator.

Temperature and Voltage-Sensitive Materials. Nonmechanical-resistance-variation devices include temperature-sensitive and voltage-sensitive materials. Temperature-sensitive materials are usually of two types–pure metals which normally have linear temperature-resistivity characteristics and semiconductors, which have nonlinear temperature-resistivity characteristics.

These materials are usually used as an arm or arms of a bridge circuit and the bridge used as previously mentioned. Where the resistance change is sufficient, they can also be used as the frequency-determining components of phase-shift or blocking oscillators.

Typical of the pure-metals are platinum, tungsten, nickel and copper.

Fine-wire grids of metals, embedded in a protecting material, can be fixed to an object whose temperature is to be measured. Response time of the wire elements may be controlled to some degree by varying the wire diameter.

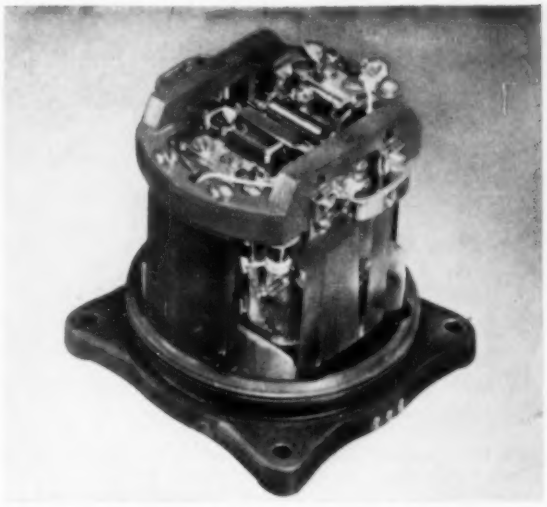
In contrast with metals, which often have small positive temperature coefficients of resistance, some semiconductors have relatively large, nonlinear negative temperature coefficients. Thermistors are probably the most widely used semiconductors. They are usually a sintered mixture of ceramic materials and manganese, nickel, cobalt or other metallic oxides, formed in various shapes. The resistance of a thermistor may change by 2.5 to 8 percent per degree C of temperature change at 20 C, in comparison with ¼ percent for average metals. Resistivity of various thermistor materials is 100 to 500 times greater than that of platinum.

Thermistors are used in much the same way as other resistive (metal) materials and are generally used over the temperature range of −60 to +300 C.

This self-heating characteristic of thermistors may be used to measure flow rates of gases and liquids, low-level air pressures (5 mm to 1 micron) and dew-points, among others. These measurements are all based on the principle that a heated thermistor will dissipate heat at a rate which is a function of the medium surrounding it.

Some types of ceramic resistors have properties similar to those of thermistors, with negative temperature coefficients of 1 to 3 percent per degree C at 25 C.

The property of certain materials, such as lithium chloride, to change in resistivity as a function of moisture absorption is used to measure relative humidity over a range of 15 to 100 percent. A humidity cell usually consists of a plastic or glass plate coated with a hygroscopic film of lithium chloride. Electrodes attached to the edges of the plate permit measuring of the variable resistance.



Giannini potentiometer accelerometer consists of magnetically damped, spring-supported mass system which actuates wiper arm of linear potentiometer through linkage system

In addition to its sensitivity to moisture, lithium chloride is also temperature sensitive to a small degree. Consequently, accurate humidity measurements with this material require temperature compensation.

Capacitive Transducers. These devices consist basically of two or more electrodes or conductors separated by an insulating material. Since capacitance is a function of the separation of the electrodes, the area of the conductors and the dielectric constant of the insulator, changing any one of these parameters causes a capacitance change which can be analyzed. For example: two fixed electrodes can be immersed in a medium of variable dielectric constant; the dielectric constant of a medium may remain fixed and the amount of dielectric varied; one electrode can be fixed and the other made to vary with the amount of dielectric. The latter two methods permit measuring volume. Angular displacement can be measured by rotating one of the

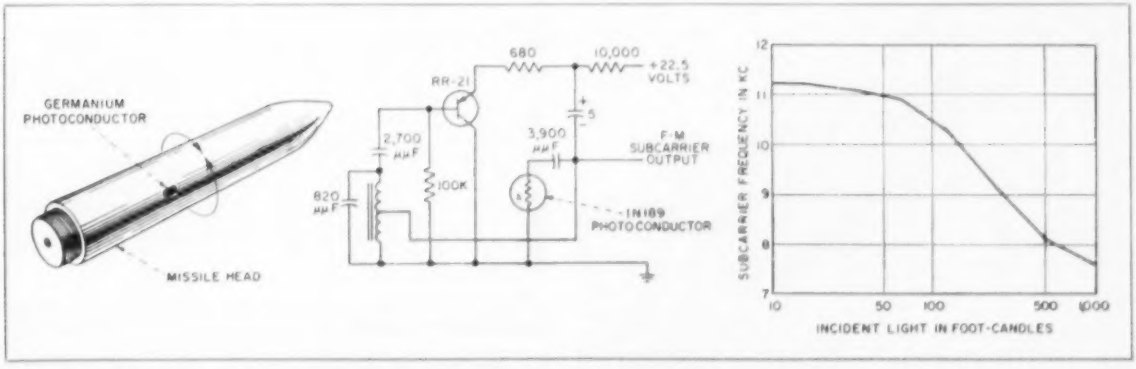


FIG. 8—Test-missile head contains germanium photoconductor which is employed as frequency-determining element of transistor f-m subcarrier oscillator. Spinning of missile causes light falling on photoconductor to vary and in turn vary subcarrier frequency

Table IV—Phosphors for Scintillation Counters

Phosphor	Chief Application	Scintillation Time in μsec
Nickel-Killed Zinc Sulphide	α particles	3.0
Thallium-Activated Potassium Iodide	$\alpha\beta$ particles γ rays	1.5
Naphthalene + 0.01% Anthracene	β particles γ rays	0.06
Anthracene	β particles γ rays	0.02

electrodes of a parallel-plate variable capacitor. This system is self-referencing as it goes through a minimum and maximum every 360 degrees of rotation.

Linear displacement is measurable by fixing one electrode and causing the other to approach it or recede from it as a function of the measurand.

Capacitor transducers may be used as frequency-determining elements of oscillator circuits or in bridge circuits.

Advantages of this type of transducer include high frequency response, high sensitivity, small to high displacement ranges, good resolution, high-temperature operation and ability to measure static quantities. Disadvantages are sensitivity to vibration and electrical noise, temperature drift and maintenance of original calibration (except for self-referencing arrangements). Sensitivity usually decreases approximately 1 percent per 20 C rise.

Piezoelectric Materials. The ability of certain materials to generate an electrical voltage when subjected to mechanical stress may be utilized in a transducer. This piezoelectric property is common to natural crystals, such as quartz and tourmaline, synthetic materials, such as Rochelle salts, ADP (ammonium dihydrogen phosphate) and ceramics such as barium titanate.

Transducers of these materials are self-generating; the electrical energy produced being linearly proportional to energy of the measurand. This property permits them to directly voltage modulate an a-m or f-m subcarrier oscillator.

Piezoelectric transducers have wide dynamic range, with virtually no hysteresis and infinite resolution. Certain types have excellent reproducibility of results. The mechanical structure of these transducers is normally stiff, causing them to be rugged and have a wide frequency-response range. They are usually limited, however, to the measurement of frequencies above 2 to 3 cps.

In all applications, electrostatic shielding, along with short cable lengths, requires careful consideration, as crystals are sensitive to electrical-noise pickup. Excessive cable lengths can also be detrimental to the signal level because of the cable's shunting capacitance.

Of the various piezoelectric materials commonly employed, no one material exceeds, in all respects, characteristics of the others. Piezoelectric ceramics are frequently used in telemetering; they have a good combination of energy-conversion efficiency, temperature stability, ruggedness and ease of fabrication into any shape. These ceramics are capable of operation from −85 to +500 F.

Piezoelectric transducers are often used for the measurement of shock and vibration, high acoustic levels, as well as fluctuating pressures. Pressure measuring and force measuring devices are capable of measuring pressures from 0.01 psi to more than 30,000 psi over frequency ranges of 3 to 25,000 cps.

Electronic Devices. Transducers which utilize the motion, production or control of free electrons can be classified as electronic. These include photoelectric, ionization, thermoelectric and other devices.

Any phenomena which produce a variation in light intensity, position or color may be measured or detected with photoelectric transducers. These include photoconductor, photovoltaic and photoemissive devices.

Photoconductive Devices. The term photoconductivity is used to describe changes of conductivity induced by illumination in a gas, solid or liquid medium. For some time selenium was the principal material used for photoconductive transducers. However, in recent years, lead sulfide and germanium devices have also become prominent.

Selenium cells may show a decrease in resistance by a factor of five when exposed to strong illumination. They pass appreciable dark-state current and are comparatively slow to respond to light changes.

Lead sulfide cells usually consist of a semitransparent coating on the inside surface of an evacuated glass bulb. They have linear illumination-versus-resistance response and low noise level and are particularly useful where frequency is less than 10,000 cps, color temperature is in the range 400 to 3,900 Kelvin, light flux is concentrated in an area

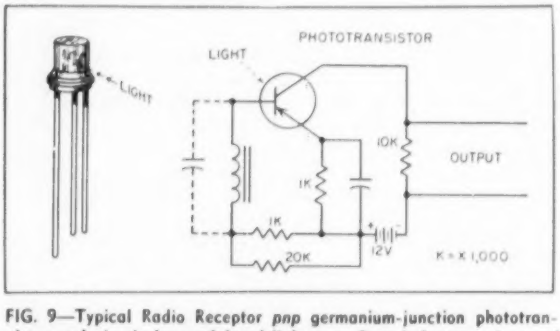


FIG. 9—Typical Radio Receptor *pnp* germanium-junction phototransistor and circuit for modulated-light use. Base inductance is tuned to light-modulation frequency for best signal-to-noise ratio

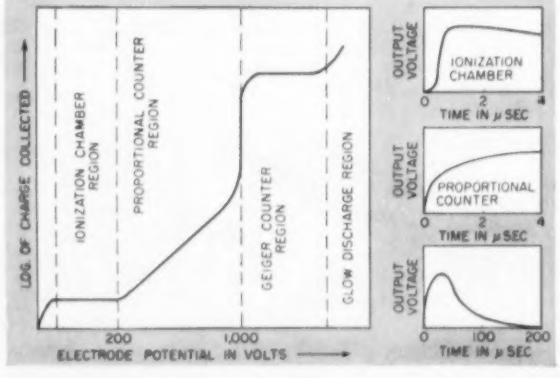


FIG. 10—Operating regions of various nuclear radiation detection instruments and shapes of output-voltage pulses. Waveshapes shown are for infinite input time constants

up to 1 sq cm and rapid response is required. A resistance change of up to 80 to 1 can be obtained.

Operation of lead-sulfide cells above temperatures of 100 C is not ordinarily recommended. A slow drift in resistance and sensitivity may be encountered if the lead-sulfide surface is exposed to air. In certain applications, temperature compensation may be required to offset the high temperature coefficient of these cells.

Germanium photoconductive devices may be either photodiodes, phototransistors or photoconductors. Photodiodes are basically germanium diodes whose resistance is dependent on incident illumination and, to some degree, temperature.

Photoconductors are germanium bars without directional characteristics. They can be used in a-c circuits without the clipping effect of photodiodes. An application is illustrated in Fig. 8. Phototransistors are essentially grounded-emitted transistor amplifiers, as shown in Fig. 9. Their characteristics are a function of $\alpha/(1-\alpha)$, where α is the current amplification factor.

All of these photoconductive devices, except phototransistors, are generally used in series with a voltage source. The variations in conductivity produce a corresponding output voltage which may be applied as discussed in previous paragraphs.

Generating Devices. Photovoltaic cells develop an internal emf when illuminated by energy in the visible, infrared and ultraviolet regions of the spectrum. Such cells usually consist of a pure metal base over which is placed a layer of semitransparent semiconductor material. Electrodes are attached to the base and semiconductor material. The barrier layer may be between the top electrode and semiconductor layers or between the semiconductor and base metal layers. The former, a front-wall cell, has greater sensitivity than the latter, a back-wall cell.

Under short-circuit conditions these cells produce a maximum output current that varies linearly with the light intensity; open-circuit output voltage increases logarithmically with light intensity. This characteristic requires that low values of load resistance be used for linearity. Output is usually used in a voltage form by producing a voltage drop across a load resistor.

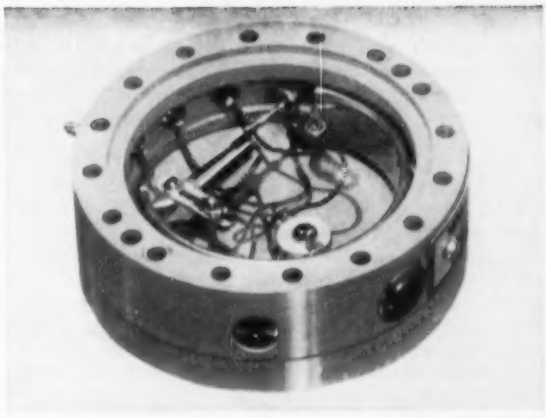
Commercially available photovoltaic cells are either copper-copper oxide, silicon *pn*-junction or iron selenide-silver. All of these devices have outputs which are proportional to the area exposed to radiant energy. A 1⅜-inch diameter silicon-junction cell will generate 0.25 v across 10 ohms in sunlight. Other cells ordinarily produce outputs in the milliampere or millivolt range.

Frequency response of these cells is affected by the large capacitances involved. With equal 60-cps on-off intervals of light, the off current can be as much as 50 percent of the on current. At 1,000 cps, the off current can be as high as 97 percent of the on current.

These devices have a tendency to become fatigued. This characteristic necessitates fairly frequent calibration in some applications.

Phototubes. Photoemissive transducers are of two general types, gas or high-vacuum diodes and multiplier phototubes.

Gas and high-vacuum phototubes consist of a semicylindrical cathode of large area, on which a photosensitive substance is evaporated, and a wire anode coaxial with the cathode. With a positive potential on the anode, photoelectrons are emitted from the cathode and collected at the anode as a function of the wave length and intensity of the light illuminating the cathode. As the light on the cell varies, the current changes, causing a variation in the voltage drop across a load resistor in series with the cell.



Giannini Bourdon-tube potentiometer pressure transducer has liquid-filled case to isolate mechanism from corrosive media and to provide damping against shock and vibration

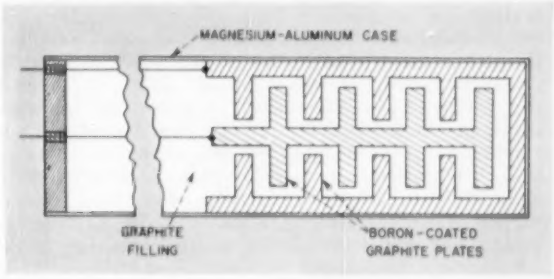


FIG. 11—Parallel circular-plate ionization chamber has boron-coated electrodes for detection of slow neutrons. Wire leads are of lead and are coated with quartz

By filling the glass envelope with an inert gas such as argon or neon, at a pressure of the order of 0.5 mm, the photocurrent for a given illumination intensity is greatly increased. Increasing the anode voltage of gas phototubes beyond a certain point causes photoelectrons traveling to the anode to ionize the gas molecules, releasing more electrons and producing an amplification effect. This gas amplification ratio is dependent on the incident-light flux in addition to the anode voltage. If amplification ratios of about 10 are reached a glow discharge usually takes place.

The ionization-deionization time of gas phototubes operating in gas-amplification regions causes an approximately 6-db drop in response at 10,000 cps relative to 800 cps.

Plate potentials of gas phototubes are required to be of the order of 100 volts d-c while high-vacuum tubes operate at about 250 volts. Both types have a maximum temperature limitation of 75 to 100 C.

To provide greater sensitivity, electrostatic electron multipliers or dynodes may be incorporated with the basic phototube. Multiplier phototubes are usually made with nine or 10 dynode stages, although any number is permissible. Each dynode is maintained at a potential from 50 to 150 volts more positive than the previous dynode. This multiplication process can increase sensitivity by about 500,000 compared to nonmultiplier phototubes. Final anode potentials of 1,000 to 3,000 volts are required.

Ionization Devices. Some transducing devices operate on the principle that a fast-moving charged particle will eject

an orbital electron from an atom if it approaches sufficiently close to the atom. Since the residue of the atom is a positively charged ion, the process is referred to as ionization and the incident particles as ionizing radiations. Utilizing this property, nuclear radiations can be measured by observing the resulting ionization when they pass through a medium such as a gas.

A typical instrument consists of a metal cylinder with a coaxial central electrode, in a gas-filled enclosure. The central electrode, the anode, is usually positive with respect to the outer electrode, the cathode. When an ionizing particle enters the gas between the electrodes, ions are formed and the positive ions are collected by the cathode and negative ions by the anode. Magnitude of the collected charge will depend on the number of initial ionizations and the voltage applied to the electrodes.

Variation of collected charge with the voltage between the electrodes is shown in Fig. 10. The characteristics vary in nature over the four voltage ranges shown in the graph.

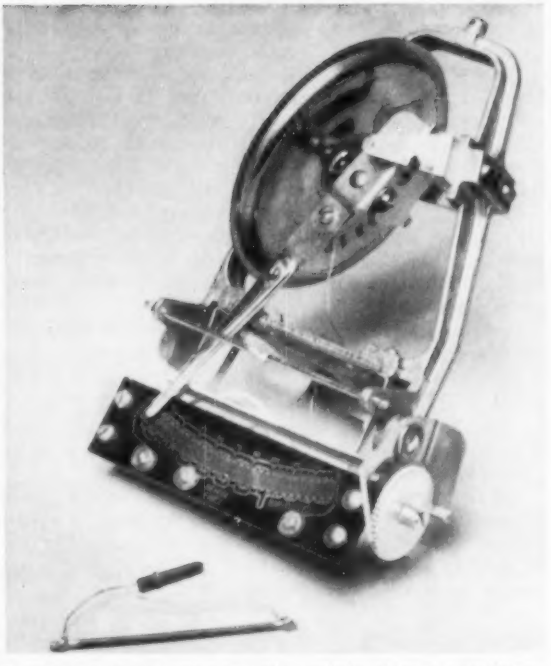
At very low voltages the ions move so slowly that many recombine before reaching the electrodes; charge collected increases with plate voltage. Increasing the voltage, a point is reached where the ions move sufficiently fast that they are all collected before they can recombine. Continuing to increase the applied voltage in this region will not increase the number of ions collected. When operating in this second region the device is called an ionization chamber. Such a chamber produces current pulses whose amplitude is proportional to the total amount of ionization in each ionizing event. Output pulses are usually of the order of 10^{-6} to 10^{-8} volts or fractions of microamperes and subsequent amplification is a necessity. By plotting the number and size of the ionizing events, the nature of the radiation can be inferred.

As the voltage applied to the electrodes is increased beyond the ionization-chamber region, the operation of the chamber enters the proportional-counter region. The proportional counter is similar to the ionization chamber except that the negative ions formed move sufficiently fast to cause secondary ionization in the gas. As a result the current pulses for bursts of radiation are larger, but proportional to the initial amount of ionization.

Increasing the electrode voltage still further causes the device to operate in the Geiger region. Geiger counters give an output pulse of constant width and amplitude for each radiation particle regardless of the number of electrons formed in the initial ionizing event.

Table V—Thermocouple Characteristics

Element	Operating Range in centigrade	Output at 100 C and 0 C in mv
Copper and constantan	−200 to +400	4.3
Iron and constantan	−100 to +300	5.4
Chromel and Alumel	0 to +1,200	4.1
Platinum and platinum-rhodium	+500 to +1,400	0.643



Transducer elements of radiosonde include, from top to bottom, barometer for altitude, thermistor for temperature and lithium-chloride coated plastic sheet for humidity measurements

Geiger-Muller tubes are usually operated with a potential of 1,000 to 2,000 volts. Depending on this voltage, the output pulses may be as high as 100 volts, permitting the output to be used directly without subsequent amplification.

In all of the ionization devices discussed, resolution of number of radiation particles is limited by the recovery time of the gas used. For argon, which is usually employed in Geiger counters, there is a dead time of 100 to 200 microseconds while the gas deionizes. This limits resolution for argon devices to 10,000 particles per second. Alcohol vapor is sometimes added to argon in Geiger counters to shorten the discharge recovery time. Resolving times of ionization chambers or proportional counters are about 200 times less than that of Geiger counters.

All of the devices discussed are sensitive to ionizing radiations such as gamma rays, cosmic rays and alpha and beta particles. Neutrons, however, do not cause ionization because they carry no charge. By using a gas such as boron trifloride, or by using boron-coated electrodes, as shown in Fig. 11, impinging slow neutrons knock alpha particles out of the boron and the alpha particles produce the necessary ionization. For fast-neutron detection, hydrogen is used instead of boron trifloride.

Pulse counting rates of the order of thousands per second, from the various radiation measuring devices, are not unusual. Consequently, scaling circuits are used to count down the number of pulses detected. Count-down scales of 32, 64 and 128 are common.

The property of phosphor materials to fluoresce or scintillate, employed in conjunction with multiplier phototubes, is another important method of detecting ionizing radiation. Gamma rays or other ionizing radiations bombarding a phosphor such as anthracene, sodium iodide or naphthalene produce flashes of light. These light flashes are picked up and amplified by the

phototube by a factor of 10^6 or more.

Scintillation counters are particularly noted for their high efficiency, counting rate and accuracy. They do, however, have a relatively high thermal noise level. Lifetimes of excited atomic states are about 10^{-8} sec and the light flashes and recovery times are corresponding short in duration (Table IV). Since the phototube output pulses are proportional to the energy of the particles causing the ionizing events, these counters are used to determine both the energy and number of the ionizing particles or photons.

Scintillation counters are usually used to measure or detect weak gamma radiation. By using phosphor containing lithium, they can be used to measure slow neutrons.

Thermoelectric Devices. Thermocouples operate on the thermoelectric principle that two wires of metals with different work functions and in physical contact at both ends will generate a circulating current if one junction is at a temperature different from the other. The value of this current will be proportionate to the temperature differential, the work-function differential of the wires and the circuit resistance.

Typical wire combinations are copper-constantin, chromel-alumel, platinum-platinum rhodium and iron-constantin. Temperature operating ranges and output voltages of these combinations are listed in Table V. Though the current may reach relatively high values, output voltage of such devices is usually limited to several microvolts.

Thermocouples are particularly suitable for measuring temperatures in localized areas. They can be securely welded to the surface under measurement, providing good transfer characteristics over the area of the weld. Average response times are such that transient temperatures of the order of 0.1 second may be measured.

Magnetic Transducers. These devices may be classified in two general categories, variable reluctance devices and emf-generating devices.

Variable-reluctance transducers usually consist of one or more coils and a core. By fixing either the coil or the core and moving the other, the length of the magnetic path through which flux linkages pass will be made to vary. These changes in magnetic path result in varying magnetic reluctance and in turn varying electrical inductance.

A typical differential transformer consists of a concentrically wound transformer with one primary winding and two secondary windings connected in series opposition. The relative magnetic linkage between the a-c excited primary and the secondary output windings is varied by changing the position of a ferromagnetic core. The output voltage is proportional to the mechanical displacement of the core, which is made a function of the quantity being measured. Its phase leads or lags the input current by a maximum of 90 degrees, depending on the displacement.

Differential transformers are usually used with excitation frequencies of 60 to 20,000 cps at up to 12 volts input. Linearity of these units can be within 0.10 percent for full-scale core displacements of 0.025 to 0.800 inch. Output impedance is of the order of a few hundred ohms.

This type of transducer is used primarily with displacement-type elements such as floats, bellows, Bourdon tubes and diaphragms.

Another group of reluctance-type transducers are essentially rotating transformers. They are similar, in appearance and construction, to miniature wound-rotor induction motors. Either the rotor or stator winding is a-c excited. The other winding then produces an output voltage which is a function of the input shaft angle and scaled to the input voltage.

These devices are analogous to resistance potentiometers. Life expectancy is high—over 10^9 cycles. Lack of a wiper eliminates contact bounce and permits speeds of 1,500 rpm. Resolution is infinite. Also, unlike resistive units, induction units have isolated input and output.

Other variable reluctance devices consist essentially of different variations of ferromagnetic-core inductors. These devices can produce as much as ±20 percent change of the initial inductance. They can be used with a-c bridges or used directly as frequency-determining elements in L-C f-m subcarrier oscillators.

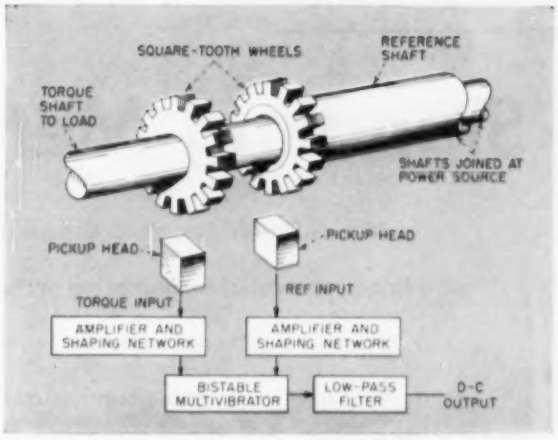


FIG. 12—Phase shift between signals from two pickup heads is proportional to amount of twist between torque-carrying shaft and reference shaft and gives indication of dynamic torque

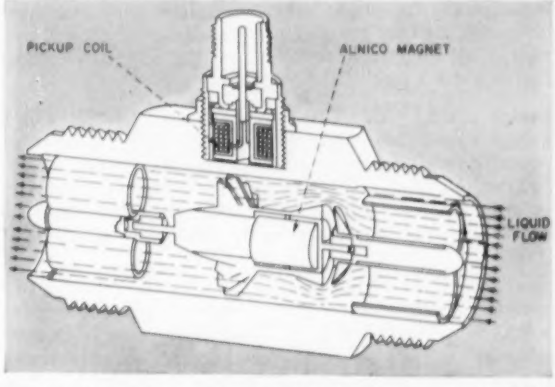


FIG. 13—Permanent magnet in hub of hydraulically suspended Potter flow meter induces signal in pickup coil. Signal frequency is proportional to flow rate; total pulses are proportional to total flow

EMF Generators. Generator types of transducers are usually characterized by a coil or conductor cutting across the lines of flux of the magnetic fields causing a voltage to be induced in the coil. Conversely, the conductors may be kept stationary and the lines of flux of the magnetic field moved. Output voltage is dependent on the number of conductors, the rate at which they cut the magnetic field and the field's strength.

One type of generator transducer consists of a permanent magnet on which is wound a pickup coil. Passing magnetic objects near the unit distorts the magnetic field and generates a voltage proportionate to the rate of motion of the objects. This principle of operation is utilized in the dynamic-torque transducer of Fig. 12 and the flow-rate meter shown in Fig. 13.

Signaling Methods

Means for sending data depend upon the transmission medium. When wire lines are available, signaling systems may be simple. More complex data call for frequency or time sharing of facilities. Radio systems depend upon available channels and type of modulation must include noise discriminating ability

INDUSTRIAL devices for transmission of data usually operate over short distances where two or more wires can be economically furnished. When several types of data must be transmitted to any distance simultaneously, electronic systems are frequently required and the original elements may become a part of the new system.

Bridge Circuit. An elementary bridge system for which a diagram is shown in Fig. 14 requires a source of constant potential and two potentiometers, one of which is moved by the measurand. Manual adjustment of the receiver potentiometer for galvanometer null gives the measurement according to a previously calibrated scale. The bridge has two arms at the transmitter and two at the receiver. Off-null galvanometer current can be used to control the rotation of a motor or clutch system so the proper scale reading is shown automatically and continuously. The transmitter arms of the bridge need not comprise a simple potentiometer. One arm *AB* can be a fixed resistor and the other *BC* a resistance thermometer. As resistance changes with temperature, unbalance causes the pointer to show temperature on the scale.

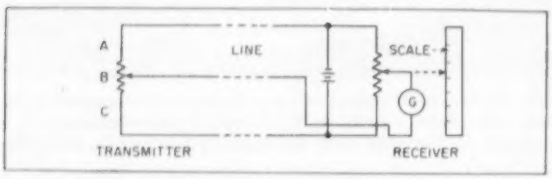


FIG. 14—Elementary bridge system requires manual operation at receiver but is easily adapted to servo balancing control

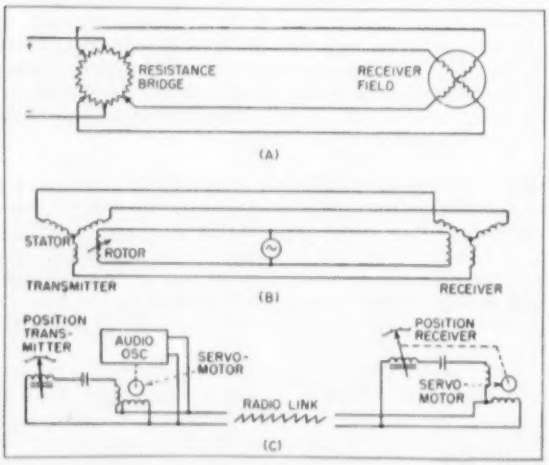


FIG. 15—Remote dial reading systems. So-called d-c synchro (A), conventional a-c synchro (B), and tuned audio system (C)

Dial Position. Direct indication of a dial position is possible by several means. Developments of ferromagnetic and permanent magnet materials have made practicable the construction of so-called d-c synchros. As shown in Fig. 15A, a tapered resistance bridge with two fixed and four sliding connections is connected to a motor-type device with two sets of paired series windings. Rotation of the bridge assembly results in rotation of the effective field.

The commonly used a-c synchro is shown at (B). Movement of the rotor relative to the stator windings results in corresponding movement of the receiving rotor. Use of a common power line for both rotors effectively reduces the control lines to three.

Another stepless positioner, directly adapted to transmission by radio or carrier uses the position-seeking tendency of a two-phase motor in which one of the windings is controlled by a series tuned circuit. If the motor is mechanically coupled to one of the elements, as the inductor in (C), the motor will automatically tune to line frequency and an indicator attached to the shaft will assume an appropriate position.

Such a remote-reading indicator can be actuated by a similar tuned circuit controlling a servomotor. In this case, the motor is coupled to an audio oscillator that furnishes the line voltage. Thus, changing the tuning by moving the position transmitter varies the line voltage. This change is automatically followed by the receiver.

Frequency Variation. A variable frequency system, of which the elements are shown in Fig. 16A, was in operation in the power field at an early date. As originally used, the transmitter was connected to the receiver by a wire line. Later systems transmit the data by carrier current or microwave link. The carrier equipment is indicated.

In the transmitter, a small variable capacitor is mechanically attached to the shaft of the instrument to be telemetered. Movement of the shaft then changes the frequency of the variable oscillator, which may be well above the audio range in order to employ small, lightweight com-

ponents that will have minimum effect on the shaft.

Mixing this frequency with output from a fixed oscillator that produces a frequency of the same magnitude is effected in the beat detector. A more usable low frequency is thereby produced.

Output from the beat detector can be fed through a wire line (as shown by the alternate dashed connection) to an amplifier and a meter calibrated in terms of the quantity to be measured.

The output can also be used to modulate a transmitter coupled through high voltage capacitors to the power line. One or more receiving units can be attached at other points along the line. Losses occurring from phase-to-phase coupling and phase-to-ground coupling attenuate the signals.

A frequency system used by Control Corp., shown in Fig. 16B, uses two frequencies somewhat in the manner of a bridge, in that two variable capacitors are in effect used at the transmitter. As the capacitance of one increases, that of the other decreases. By this means, the reaction on the measuring instrument is minimized.

Output from two oscillators is heterodyned and the desired combination from the converter is selected with a low-pass filter. After modulation and transmission to the receiver, the incoming frequency is again heterodyned with a fixed frequency, filtered and appropriately displayed on a frequency meter calibrated in terms of the measurand.

Table VI—Subcarrier Bands

Band	Subcarrier Band: Lower limit in cps	Subcarrier Band: Center freq in cps	Subcarrier Band: Upper limit in cps	Subcarrier Deviation in percent	Nominal Intell freq in cps	Maximum Intell freq in cps
1	370	400	430	± 7.5	6	30
2	518	560	602	± 7.5	8	40
3	675	730	785	± 7.5	11	55
4	888	960	1,032	± 7.5	14	70
5	1,202	1,300	1,398	± 7.5	20	100
6	1,572	1,700	1,828	± 7.5	25	125
7	2,127	2,300	2,473	± 7.5	35	175
8	2,775	3,000	3,225	± 7.5	45	255
9	3,607	3,900	4,193	± 7.5	60	300
10	4,995	5,400	5,805	± 7.5	80	400
11	6,799	7,350	7,901	± 7.5	110	550
12	9,712	10,500	11,288	± 7.5	160	800
13	13,412	14,500	15,588	± 7.5	220	1,100
14	20,350	22,000	23,650	± 7.5	330	1,650
15	27,750	30,000	32,250	± 7.5	450	2,250
16	37,000	40,000	43,000	± 7.5	600	3,000
17	48,560	52,500	56,440	± 7.5	790	3,950
18	64,750	70,000	75,250	± 7.5	1,050	5,250
Optional Bands						
A.	18,700	22,000	25,300	±15	660	3,300
B.	25,500	30,000	34,500	±15	900	4,500
C.	34,000	40,000	46,000	±15	1,200	6,000
D.	44,620	52,500	60,380	±15	1,600	8,000
E.	59,500	70,000	80,500	±15	2,100	10,500

These bands can be used by omitting adjacent bands

Cam Type. An impulse-duration telemeter suitable for slow-speed data is shown in Fig. 17. A signal is transmitted every twelve seconds. This principle is used in equipment manufactured by the Foxboro Co. The contactor shown at the left has two degrees of freedom. It can be positioned around its axis by the motion of a pickup. It normally rides on the back surface of the cam, during which time a switch is closed. The cam rotates in the direction shown at 5 rpm.

As the cam rotates, the contactor is off the cam for a portion of each cycle, depending upon its position in relation to the cam axis. Because the position is determined by the measuring element, the time during which the contactor is off the cam is proportional to the measurement. The switch is thus closed for a period proportional to the measurement.

At the receiver, a similar cam is motor driven in synchronism. When the transmitter is energized, relay K_1 closes and connects one side of the up winding for the reversible motor, assuming that the receiver cam switch is open. Its contactor is likewise movable and is positioned by the reversible motor.

By using a clamping mechanism, the contactor is allowed to move only during a short reset period at the beginning of each cycle. When the contactor is off the receiver cam K_2 operating the other coil (down) is energized providing the transmitter switch is open.

When both transmitter and receiver switches are closed or open simultaneously, neither motor coil is energized and the pointer does not move. Two telemetering systems for power and water-level data, shown in Fig. 18, are manufactured by General Electric. Only the elements of the systems are described here.

The transmitter for a-c measurements is shown at the left of (A). A watt-hour mechanism is used to translate the a-c electrical quantity into a varying rotational speed. A light-modulating disk is mounted on the shaft of the watt-hour meter. The serrated edge of the disk (shown in the drawing as a series of holes) interrupts the light falling on a phototube. The disk is shaped so that phototube output varies sinusoidally with time.

There is a 21-cycle range, between 6 and 27 cps, from minimum to maximum input. The cathode follower reduces output impedance of the phototube to avoid extraneous a-c pickup. The following amplifier provides sufficient output to operate radio or carrier equipment.

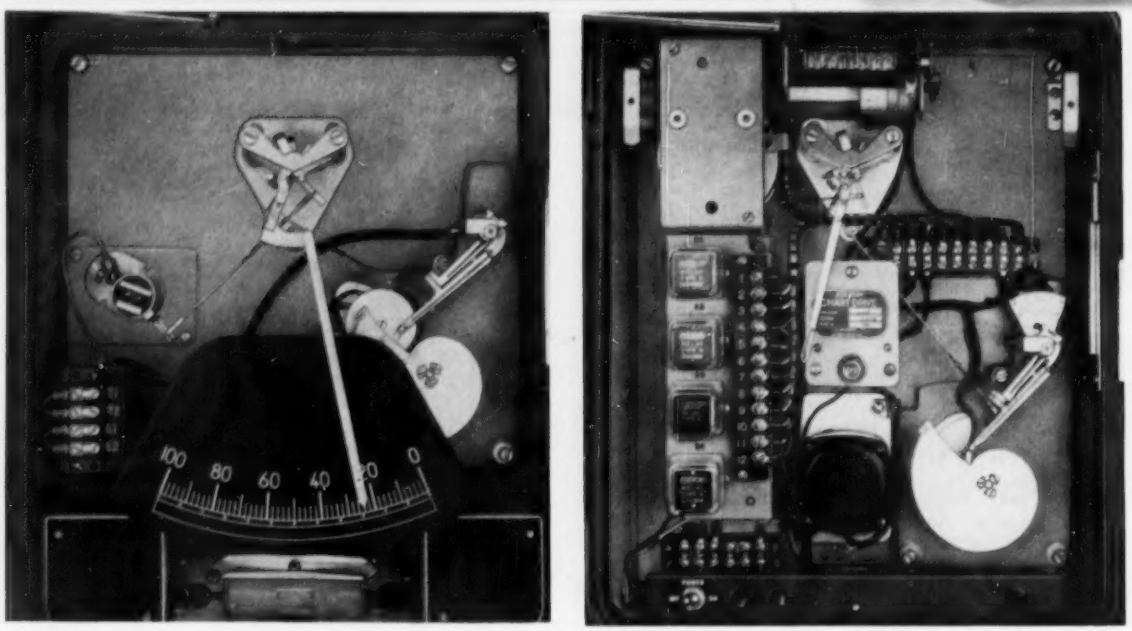
Zero indication is accomplished using a constant-torque element driven from a constant-voltage transformer. This torque adds directly to that of the primary detector. When there is no output to the primary detector, the constant torque causes the light modulating disk to revolve at such speed as to result in 6-cps output.

At the receiver (right) the signal goes through a low-pass filter that attenuates all frequencies above 27 cps. Square-wave input to a saturating transformer is provided with a limiter, inverter and power amplifier. Transformer output is a square-wave pulse of constant energy content. Rectification of the pulses gives a d-c output through a constant-resistance load that varies with the input frequency.

The end device is an indicating or recording milliammeter with the scale graduated in units of the measurand. Since zero reading is actually determined by the constant-torque 6-cps output from the transmitter, a failure of the system results in a below-zero indication. Alternatively, the subzero reading can be used for special signaling purposes.

The transmitter (B) used for d-c measurements converts a millivolt or milliampere signal into the conventional 6 to 27-cps frequency range. Input, reference and feedback signals are applied to a sensitive galvanometer system that detects any unbalance. If the galvanometer mirror is deflected, a beam of light is reflected onto the cathode surfaces of a double phototube with its sections connected in series.

This phototube is one element of a relaxation oscillator



This telemeter transmitter (left) uses a cam to transmit the temperature pickup reading. The receiver (right) has a reversible motor that moves in either direction or remains motionless. A pen is attached to the drive

that operates over the range from 12 to 54 cps. Its output is amplified through both grids of a double-triode tube that functions as a bistable multivibrator. In this circuit, the frequency is halved and the output at 6 to 27 cps is connected through output amplifiers.

Tone Combinations. Data is frequently sent by audio tones, either singly or in combination. One system manufactured by Motorola uses two pulses of two tones each. Each pulse takes about 0.75 second with a delay of 0.2 second between the end of the first and the beginning of the second. Such systems are used in communications work for selective calling of mobile vehicles or aircraft. Tones are also used in the control of oil pipe lines. For purely data purposes they are needed in the remote operation of broadcast stations. The Federal Communications Commission provides that continuous measurement be made of frequency and modulation characteristics.

Missile Systems. Military telemetering in current use tends towards either pwm/f-m or f-m/f-m. They are both capable of handling several data channels. Pulse-width modulation of a frequency-modulated carrier (pwm/f-m) is a time-sharing system. As such it has limitations in accuracy for fast-changing information. Frequency-modulating one or more subcarriers of a frequency-modulated transmitter (f-m/f-m) provides instantaneous continuous presentation of several data channels. It is likely, however, to be more prodigal of bandwidth.

The principles of the two systems are shown in Fig. 19. The pwm/f-m system provides from 30 to 90 channels with frequency response up to about 2 cps. The composite signal resulting from the commutation is a series of pulses on an f-m carrier. The width of the pulse is analogous to the measurand. The system automatically corrects each revolution measuring zero and full scale.

F-M/F-M System. Current standards permit as many as 18 frequency multiplexed subcarriers from 400 cps to 70 kc. The telemetry standards in Table VI show that each subcarrier can be modulated ±7.5 percent. The higher channels can be modulated ±15 percent if alternate

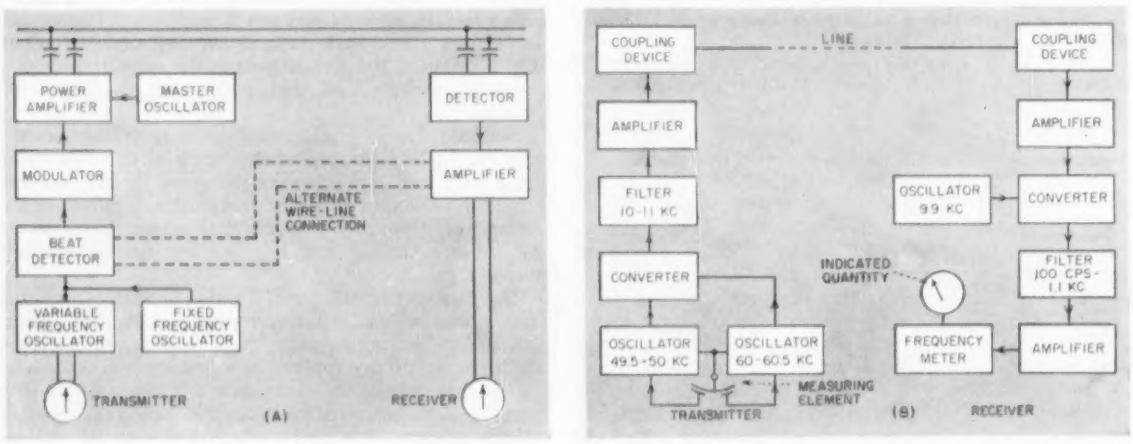


FIG. 16—Frequency telemetering system depends upon transmission of audio tone (A). Variation of the system uses two oscillators whose frequencies are varied in opposite directions (B)

channels are omitted. Limiting accuracy in the f-m/f-m system is the frequency stability of the subcarrier oscillator.

There are other modulation systems possible and some of them have been used. Pulse amplitude modulation of an f-m carrier (pam/f-m) permits the output of a high-speed switch to frequency modulate an f-m transmitter directly. This permits telemetering a large number of channels with a frequency response in excess of that using present time-multiplexed systems. It would allow sampling each of 100 channels 500 times a second for a channel response of better than 100 cps. Such a system could combine the frequency capability of f-m with the automatic error correction of any time-multiplexed system.

Pulse Code. High accuracy could be obtained from a pulse code system in which the transducer output is translated into a binary code and thus transmitted. Data could be presented at the ground station in either analog or convenient binary form for processing.

At the present time, equipment light enough for either missile or general aircraft use by which data could be encoded in binary form is not in general use, although a system has been developed by engineers of Radiation, Inc.

Modulation Systems. Various types of modulation are shown in Fig. 20 and their characteristics of bandwidth of pulse code modulation systems in terms of bandwidth and signal-noise ratio are shown in Fig. 21.

Telemetering uses a radio-frequency band between 216 and 235 mc. The specific carrier frequency will usually depend upon the facilities of a government test range

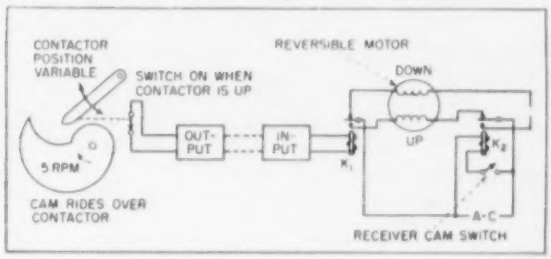


FIG. 17—Position of mechanical contactor arm relative to rotating cam is compared with a similar cam that controls direction of rotation of motor to move receiver dial in the Foxboro telemeter

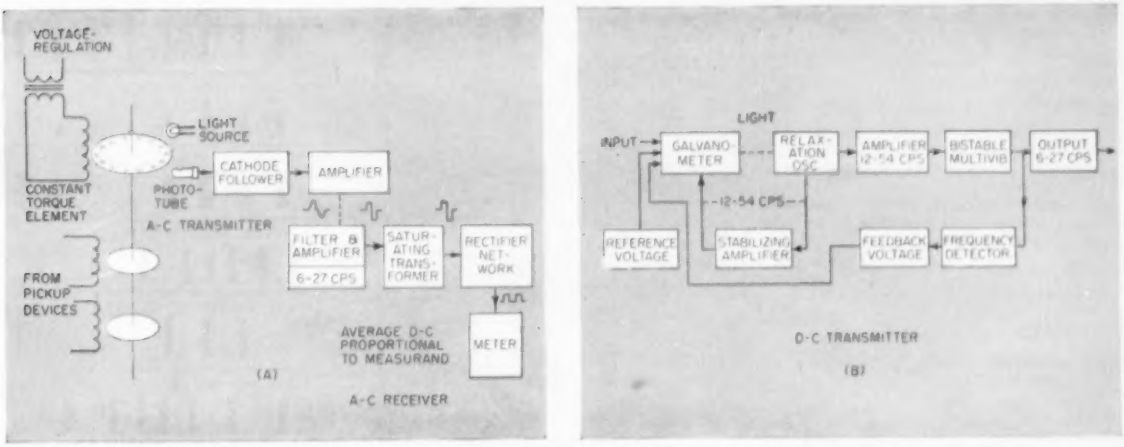


FIG. 18—Power-line telemetering system sends low-frequency pulses derived from rotation of disk between light and phototube caused by variation in a-c parameters (A). Information derived from d-c is transmitted by equipment (B)

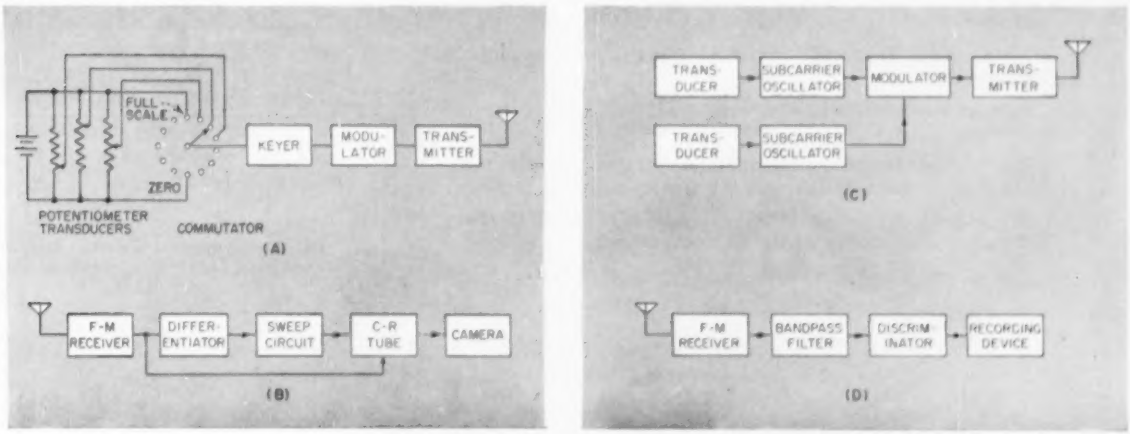


FIG. 19—Basis of pulse-width modulation of a frequency modulated carrier (pwm/f-m) transmitter (A) and receiver (B). Two-channel f-m/f-m transmitter (C) and receiver (D)

Table VII—Bandwidth and Noise

MODULATION METHOD	TRANSMISSION BANDWIDTH	SIGNAL-NOISE
AMPLITUDE (a-m)		
double sideband and carrier	$2f_m$	$(S/N)f_m = (C/N)f_t$
single sideband and carrier	f_m	
single sideband	Δf_m	
FREQUENCY (f-m)		
wideband ($f_m < f_d$)	$2f_d$	$(S/N)f_m =$
narrowband ($f_m > f_d$)	$2f_m$	$\sqrt{3}\,(C/N)f_t\,(f_d/f_m)$
frequency shift—Usually at least the third harmonic of the keying frequency f_k must be transmitted, thus $f_m = 3f_k$, using this value of f_m see above		
PHASE (p-m)		
double sideband and carrier	$2f_m$	$(S/N)f_m = \phi\,(C/N)f_t$
$m_p < 60°$		
$m_p > 60°$	Required transmission bandwidth increases greatly as depth of modulation is increased beyond about 60 degrees	
single sideband and carrier		
$m_p < 60°$	f_m	
PULSE		
height.....(phm)	Depends on repetition rate, wave-shape, and duration of pulse: for approximations use $2/t_p$ where if t_p is duration of pulse in microseconds, transmitted bandwidth is in megacycles per second	
width.....(pwm)		$(S/N)f_m = m_w f_t\,(C/N)f_t$
rate.....(prm)		
number.....(pnm)		
displacement....(pdm) (pulse displaced either in position or time)		$(S/N)f_m = t_m f_t\,(C/N)f_t$
PULSED		
amplitude (pam)	$8f_m$	Inferior to unpulsed modulations of like type unless pulse rate is very high and transmitted bandwidth is very wide
frequency (pfm)		
phase (ppm)		

$(C/N)f_t$ is ratio of peak carrier to peak fluctuation noise in transmission channel f_t cycles per second wide.

$(S/N)f_m$ is ratio of peak signal in output channel to peak noise (due to fluctuation noise) in output channel f_m cycles per second wide.

f_d is maximum deviation frequency of frequency-modulated carrier in cycles per second.

f_m is maximum frequency component in modulating wave in cycles per second.

f_t is frequency bandwidth that is transmitted; that is, it is the bandwidth of the modulated carrier that is passed by the system.

Δf_m is frequency interval between lowest and highest frequency components in modulating wave.

m_p is maximum deviation angle of phase-modulated carrier in degrees.

m_w is maximum width modulation factor for pulse width modulation.

t_m is pulse displacement produced by pulse modulation, in seconds.

t_p is duration of transmitted pulse in seconds, for frequency in cycles per second.

ϕ is peak phase deviation in radians of phase-modulated carrier.

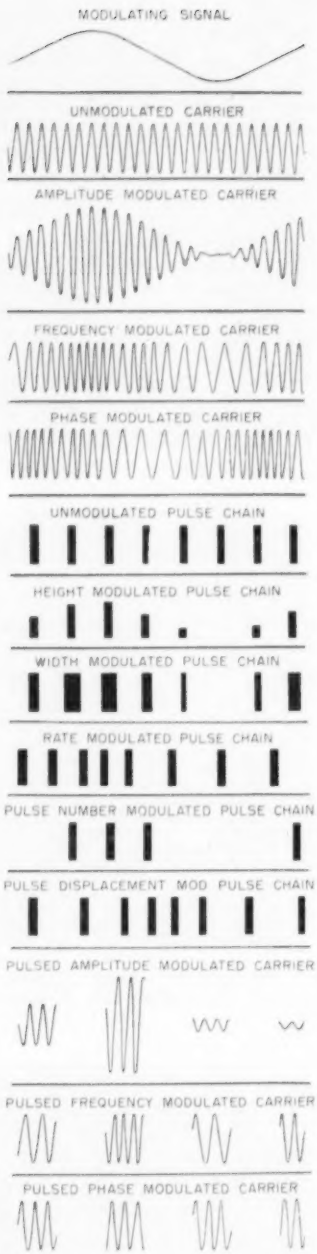


FIG. 20—Comparison of various types of modulation useful in telemetering data

and the bandwidth of the information to be transmitted.

Beacon Telemetering. The data transmitting set illustrated, built by Stavid Engineering, is a subminiaturized airborne unit that operates in conjunction with a radio beacon to telemeter data to the ground. The set provides an instrumentation facility that is supplementary to the normal ground-radar tracking of rocket-propelled missiles. The system utilizes the existing r-f link between beacon and radar as an information path.

This ppm telemetering set has a data capacity of ten channels at a maximum sample rate, for each, of 100 per second. Integral pickup and data conversion circuits are included to measure temperature, vibration amplitude, vibration frequency, the radio beacon peak power output, B+ voltage and filament voltage.

The unit, developed for the U. S. Army Signal Corps, contains the system multiplexing and pulse-position modulation circuits for handling nine 0 to 5-volt d-c input data signals and one 6 to 7-volt d-c synchronization signal.

Subcarrier Discriminator. One type of receiver output device is shown in Fig. 22. Units of this type are used to produce useful output from the f-m subcarrier.

Industrial PCM. At least two manufacturers (Bendix Pacific and Vapor Recovery Systems) employ variations of pulse-code modulation in industrial data transmission systems. In one, a circular dial calibrated in degrees is moved relative to a pointer. At the receiving end a similar dial is caused to be illuminated at the proper angle. Alternatively, a 120-lamp matrix and switching circuit gives direct readout of the appropriate number.

The actuating dial is connected to a commutator disk on which ride seven brushes. The commutator segments take the form of a minimum error or Gray binary code. Depending upon the segments contacted, anywhere from one to seven audio tones are transmitted to the receiving decoder. Signaling is essentially an on-off function comparable to teleprinter coding.

The minimum-error or reflected binary code differs from the natural binary code as shown by the example given in Table VIII. The rearrangement of the binary numbers has the advantage that adjacent binary numbers differ by only one digit. Coding errors resulting from mechanical imperfections in the coding device are thus greatly reduced.

Table VIII—Decimal and Binary Numbers

Decimal	Natural Binary	Minimum Error
0	000	000
1	001	001
2	010	011
3	011	010
4	100	110
5	101	111
6	110	101
7	111	100

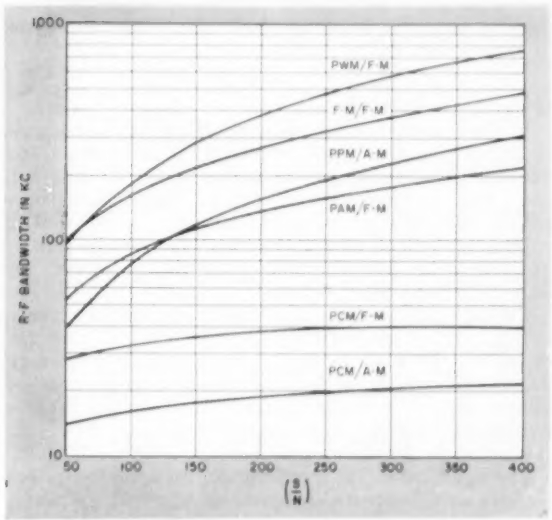
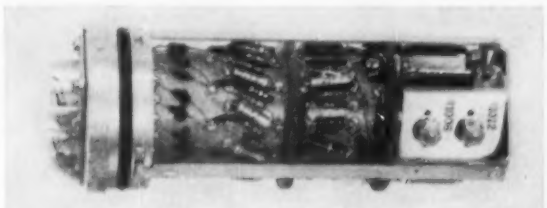


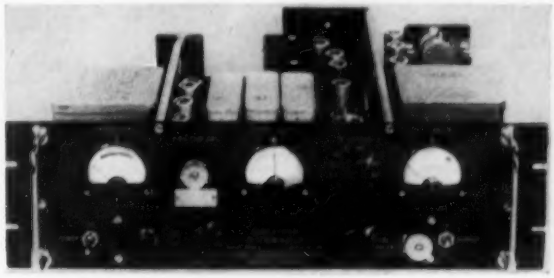
FIG. 21—Pulse-code signaling systems compared with other types on the basis of signal-noise ratio and bandwidth

Fluid Measurement. A system employed by Varec, while essentially the same in that it employs pulse-code modulation, differs in many details. It is designed primarily to telemeter liquid level readings accurate to the nearest $\frac{1}{8}$ inch. Transmission of the binary code indications is somewhat unconventional in that instead of marks and spaces (like the teleprinter) the system uses dots and dashes. A dot represents an off and a dash an on pulse.

The binary code wheels are set up through appropriate gearing to be rotated by a float. The disk in Fig. 23A is used to send inches and fractions while that at (B) sends feet and tens of feet. Brushes bearing against the code disks are connected to commutator segments on another disk that encodes the dots and dashes.

As the propelling motor is called upon by the receiving station to send out the code, a pair of brushes contact





Signal Corps telemetering unit designed by Stavid Engineering

Subcarrier discriminator built by Electro-Mechanical Research (right)

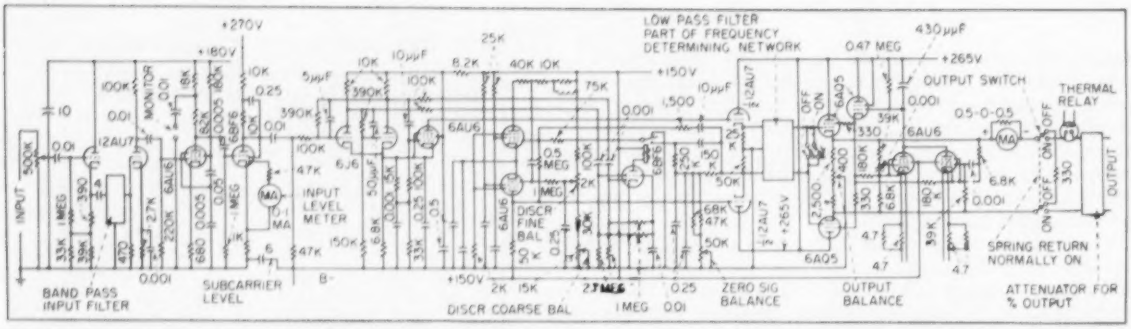
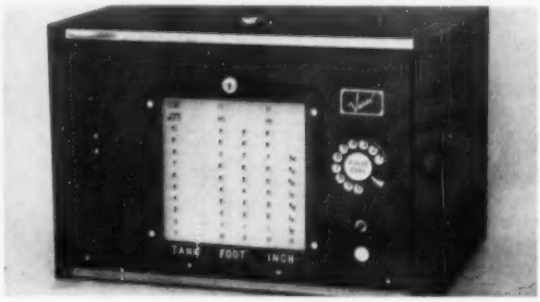


FIG. 22—Circuit diagram of linear multivibrator type of subcarrier discriminator. Plug-in filters permit use on any of the standad channels. Output limiting circuit protects the load (such as recording galvanometer) if output becomes unbalanced in excess of ± 150 percent full scale

circles of short and long conducting segments. In any case, the short-time contacts are made and sent out. If the binary code disk brushes associated with the commutator segments are making contact, a dash is sent out instead, by extending the time otherwise sent as a dot. An ancillary dial circuit allows selection of the desired tank. **Project Vanguard.** In the research program planned for the International Geophysical Year is exploration of the region 200 to 300 miles above the earth. To obtain information for a period longer than that usually afforded by use of a rocket, it is proposed to cause an earth satellite to orbit around the earth at a velocity of some 18,000 miles an hour.

Present plans call for the first instrumental satellite to weigh 21.5 pounds. It will be a metallic sphere with a diameter of at least 20 inches. Among the phenomena it will observe are temperature and pressure, density, strength of the earth's magnetic field, ultraviolet spectrum of the sun and cosmic radiation.



Receiving station for liquid level pulse code telemetering system

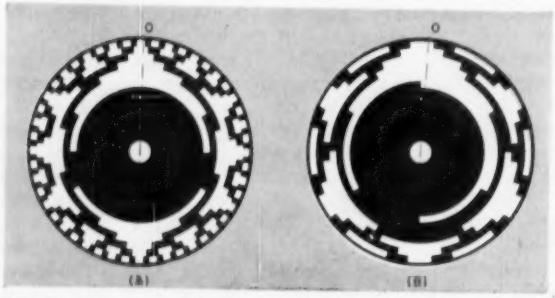


FIG. 23—Binary code disks used to sense fluid level and convert it to pulse code. Disk (A) measures inches and (B) measures feet

While a satellite of the size contemplated will be unable to transmit all these data, several could be observed and transmitted simultaneously or in sequence. To save battery power, it may be necessary to control data transmissions from the ground as indicated in Fig. 24, turning on the equipment during the time that signals can be received as the satellite makes a revolution around the earth once every 90 minutes.

Optical tracking using phototheodolites would be satisfactory and least expensive, except for the fact that the object will be hard to spot. In cloudy weather, even the favored periods previous to sunrise and after sunset will be useless. A miniature radio transmitter that radiates a signal to sensitive ground receivers will undoubtedly be employed.

The exact nature of the Minitrack equipment has not been revealed but the function of the radio links is shown in the drawing.

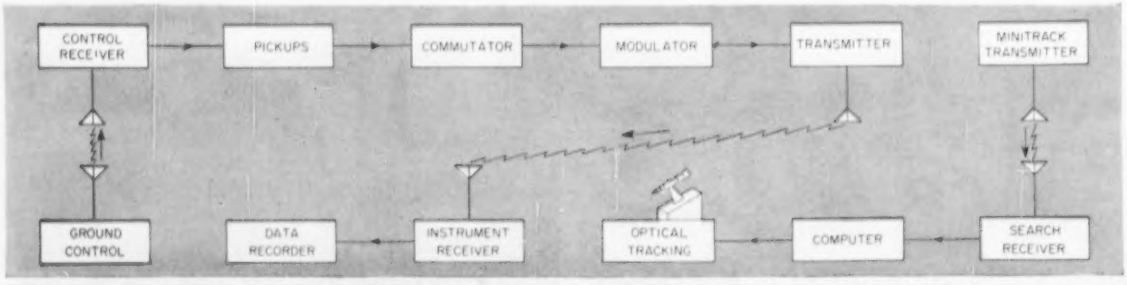


FIG. 24—Possible arrangement of tracking and telemetering equipment to observe phenomena between 200 and 300 miles above the earth from the Vanguard satellite on its orbit about the earth

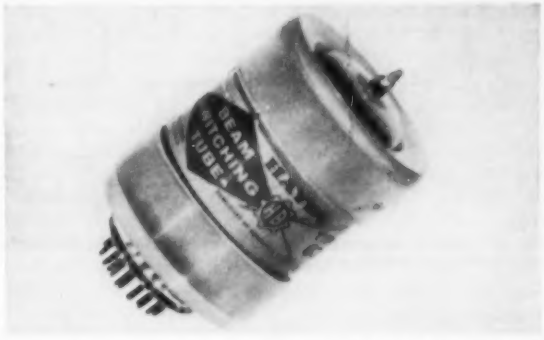
Commutating Devices

Radio channels or wire lines can generally be used for more than one kind of information. If data characteristics are changing slowly, time sharing can be employed. Switches that connect the various measurands to the modulator may be mechanical, semiconductor or electron-tube devices

TIME SHARING of telemeter channels is possible if the data to be transmitted are changing slowly. Sampling temperatures in the free air with equipment lifted by a free balloon requires only a simple switching device. Recording the outputs of a large number of strain gages at the instant of impact will permit of no time sharing owing to the short-term nature of the phenomenon. Sufficient channels must be provided to transmit data for all the parameters.

It is a rule of thumb that ten points are necessary properly to identify a sine wave. By simple arithmetic it can be shown that as the frequency of the wave increases, the speed of the commutator must be raised. This rule also imposes an upper frequency limitation on commutator operation in practice.

There are multicontact, motor-driven rotary switches



Beam switching tube of a type being used in telemetering equipment

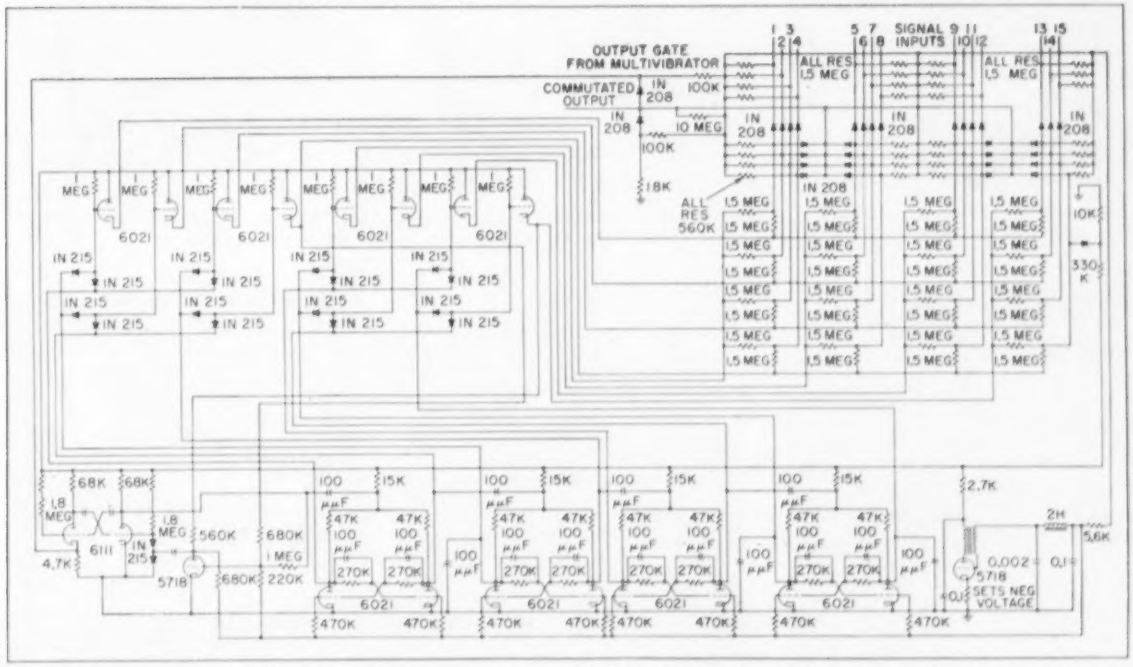


FIG. 25—Circuit diagram of an electronic commutator using tubes and diodes. Time sharing of radio-frequency channels is possible without use of rotating devices when fifteen channels are employed. Equipment is built by Electro-Mechanical Research

Baroswitch operated by the variation of atmospheric pressure in weather sounding radio telemeter switches the signal elements

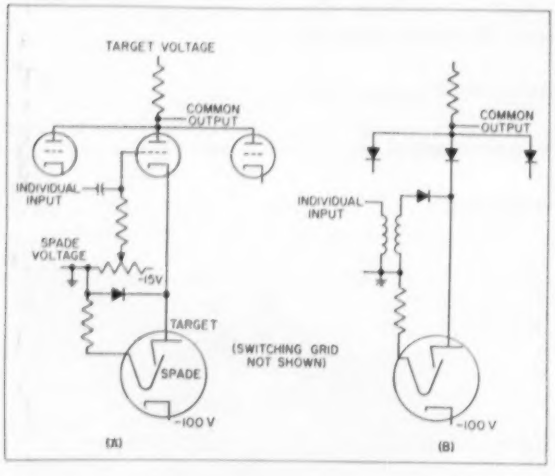


FIG. 26—Typical beam-gated sampling circuits using the Burroughs magnetron beam switching tube built by Haydu.

with standard sampling rates of 900 samples a second. The rate for a given channel is generally limited to about 20 per second (or a sine-wave frequency of 2 cps).

Diode Switches. Another approach, which involves no moving parts, is an electronic sampler handling 15 inputs. Using silicon diodes the switch samples as high as 15 kc and is basically able to go as high as 100 kc. One version of the device is shown in a photograph (circuit in Fig. 25).

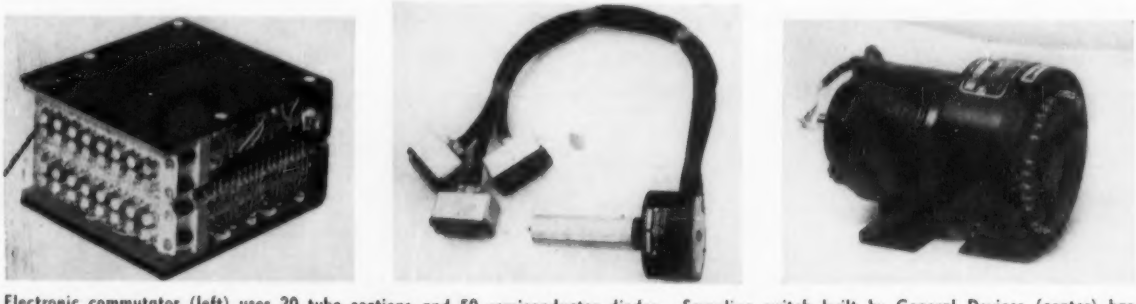
Tube Switches. Electron tube devices are being used in the field of military telemetering. One electron-beam tube, manufactured by Haydu Brothers, uses a switching grid, a spade and a target output plate as its basic electrodes. The switching grid is designed to initiate high-speed sequential switching without drawing current.

The two circuits in Fig. 26 show typical beam-gated sampling methods for switching a number of inputs to a common output. At (A) the cathode gated triode is normally cut off. The beam clamps the target to ground, turning the triode on with the same voltage across it each time.

The input at that position is the only one effective at the output. Positive clamping to ground permits individual grid bias position control.

If the inputs to be sampled are low impedance, the crystal diode gate circuit at (B) can be used. Isolation crystal diodes between circuits are necessary.

The sampling or commutating device in a modern weather radiosonde, Fig. 27, uses 150 segments of conducting metal alternating with insulating strips. An aneroid capsule moves the contacting brush. The circuit detail (B) is arranged for selective sampling such that humidity is switched on at low altitude.



Electronic commutator (left) uses 20 tube sections and 50 semiconductor diodes. Sampling switch built by General Devices (center) has three poles with 60 shorting channels for each pole. Unit at right, operating at 1,800 rpm, is used in ground tests

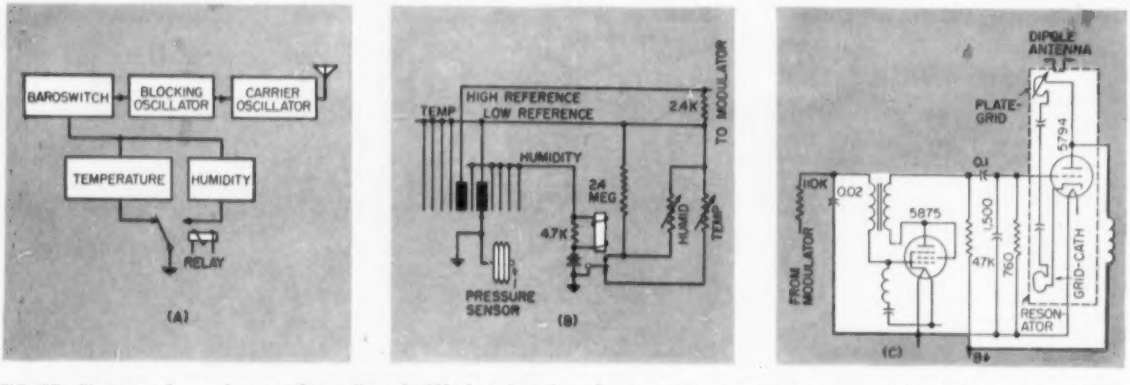


FIG. 27—Elements of a modern weather radiosonde (A) that show dependence upon the commutating system (B). Modulator and r-f transmitter shown at (C) transmit tones representing weather measurements

Output Indicators

At the receiving end of a telemetering system, the transmitted data are recorded in some form of information storage device — paper tape, magnetic tape, photographic film, punched cards — or displayed visually. Recorded data are played back and processed as needed

QUITE OFTEN, incoming received signals are recorded initially on magnetic tape. The recorded information is then played back, processed and recorded again, usually on one of the various other recording mediums.

In time-division systems, the telemetered information is stored by recording the leading and trailing edges of the received pwm signal as positive and negative pulses on magnetic tape. The recorder playback circuits recreate the original rectangular wave at the output signal. The signal is applied to a data-reduction system, which decodes the original multiplexed signal into its components. These signals are then recorded on an oscillograph or other device. Analogously, in frequency-division systems, the received information is stored on magnetic tape in the form of a frequency-modulated signal. The playback signal is processed and recorded.

Magnetic-tape recorders are of two types, amplitude modulated and frequency modulated. Amplitude-modulated recorders are similar to standard tape recorders except that frequency response is extended over a range of 100 to 100,000 cps by increasing the tape speed and using special head designs. In addition, special instrumentation is employed to minimize flutter and wow. Heads are available that will permit recording up to 28 different tracks, with an accuracy of 20 percent of full scale.

The overall bandwidth of f-m tape recorders is the same as that for a-m recorders. Accuracy, however, is about 2 percent of full scale. Individual tracks may be multiplexed to provide an even greater number of channels at the expense of limiting individual information channels to 0 to 5,000-cps frequency response.

Information from the data-reduction system is usually applied to a direct-writing oscillograph, galvanometer oscillograph, cathode-ray oscillograph or self-balancing

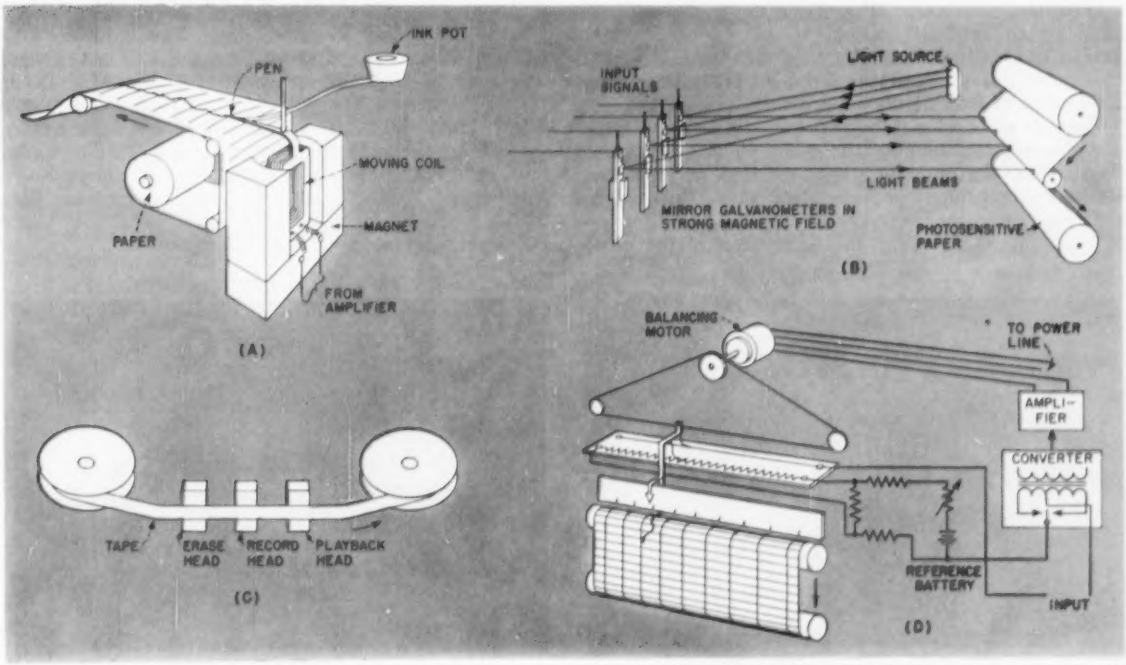
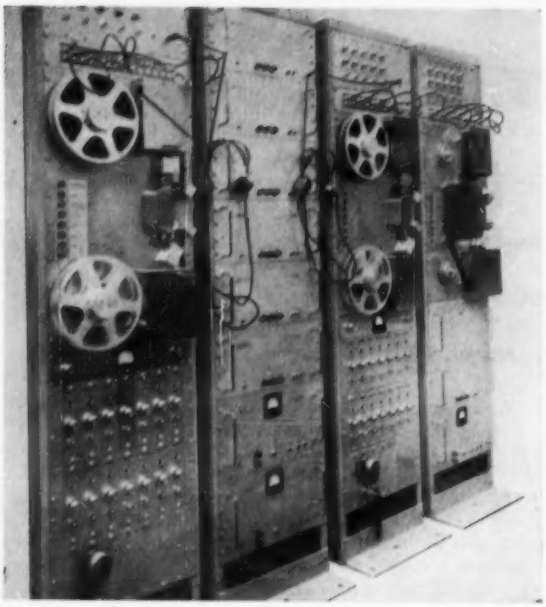


FIG. 28—Typical data recording devices include direct-writing oscillograph (A), galvanometer oscillograph (B), magnetic-tape recorder (C) and self-balancing recorder (D). Telemeter signals are usually stored on tape then played back, processed and recorded on one of other types of recorders. Information is processed as many times as necessary to get into desired final form



Double 14-track magnetic-tape data recorder system built by A-V Mfg. Corp. runs one machine while other is reloaded with tape. End machine reproduces loops for repetitive analysis. Tape speed is 60 ips

recorder. In choosing a recorder, factors such as sensitivity, input impedance, method of registration, cost, accuracy, coordinate system, linearity, resolution, response speed, drift stability and number of channels should be considered.

Oscillographs. Individual channels of direct-writing oscillographs consist of a pen moved across a paper tape by a D'Arsonval movement (Fig. 28A); the movement energized by an amplifier integral in the recorder. These devices can have up to six channels, each channel capable of 0 to 100 cps. response with 5-percent full-scale accuracy. Calibration is generally desirable shortly before use.

Each channel of a galvanometer oscillograph consists of a galvanometer movement to which a mirror is attached (Fig. 28B). The image of a light source is reflected from the mirror to a roll of photosensitive paper. Input signal variations cause the galvanometer movement and mirror to rotate, in turn causing the light beam of the mirror to scan the photosensitive paper. These instruments are made with up to 48 separate channels; each channel capable of 0 to 8,000 cps frequency response with an approximate full-scale accuracy of 2 percent. Most instruments of this type have provision for interchanging galvanometers with widely varying characteristics.

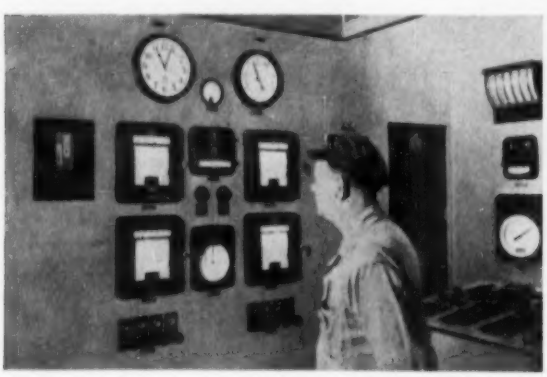
Cathode-ray oscillographs can consist simply of a cathode-ray oscilloscope with a motion-picture camera attached to the screen. Accuracies of 5 to 10 percent and frequency response of 0 to 10 mc are available with these instruments. The number of channels is determined by electronic switching circuits and is usually limited to eight.

Null Recorder. Self-balancing recorders (Fig. 28D) compare the input signal, in a bridge circuit, with an internal reference signal. A servo system keeps the bridge balanced. When the bridge is unbalanced by a change of the signal being measured, the servo system rebalances the bridge moving the indicator arm. These recorders are usually limited to one or two channels per unit. Each channel is capable of 0.5 to 24 sec full-scale balance time with 0.25-percent full-scale accuracy. The amount of information handled per channel is sometimes increased by mechanically time-multiplexing the input signals.

Acknowledgement. The authors are grateful to those in the industry who contributed information from which this article was assembled. They wish particularly to thank the following individuals: Elliot Gruenberg; Leon Hillman; Serge Korff; J. K. Kulansky; Sherman Rigby and Kenneth M. Uglow.

Organizations that assisted include: Applied Physics Laboratory, Johns Hopkins University; Applied Science Corp. of Princeton; A-V Manufacturing Corp.; Avien, Inc.; Avion, Division of A.C.F. Industries, Inc.; Bailey Meter Company; Bell Telephone Labs.; Bendix Aviation Corp., Pacific Division; Bristol Co.; Bureau of Ordnance, Department of the Navy; Consolidated Engineering Corp.; Electro-Mechanical Research, Inc.; The Foxboro Co.; General Devices, Inc.; General Electric Co.

Also G. M. Giannini & Co., Inc.; Gulton Mfg. Corp.; Haydu Brothers of New Jersey; Naval Research Laboratory; Nems Clarke, Inc.; Research Division, New York University College of Engineering; Potter Aeronautical Co.; Radiation, Inc.; Radio Frequency Labs., Inc.; Raymond Rosen Engineering Products, Inc.; Statham Laboratories, Inc.; Stavid Engineering; Taller & Cooper, Inc.; The Vapor Recovery Systems, Inc.; Vitro Laboratories.



Indicating panel of power station has linear and circular self-balancing recorders to record steam-gas and air, feedwater and other temperatures on continuous basis

Data recorded on multitrack paper-tape oscillograph, at receiving end of telemetering link, is read off by engineering staff for subsequent interpretation and evaluation

Glossary of Telemetering Terms

(condensed from AIEE suggested terminology)

ACCELEROMETER—instrument that measures one or more components of acceleration.

ACCURACY—if an indicated or recorded value, is a measure of conformity to an accepted standard.

AMBIENT—surrounding medium.

AMBIENT CONDITIONS—such as pressure, temperature.

AMPLITUDE MODULATION—(a-m) conveys intelligence by varying the amplitude of a wave.

BAND—limited continuous region which is part of a more extended region. Used in connection with frequencies and pressures.

BANDWIDTH—extent of the band.

BAUD—a unit of signaling speed derived from the duration of the shortest code element. Speed in bauds is the number of code elements per second.

BIDIRECTIONAL PULSES—single polarity pulses, not all of which have the same sense of departure from normal.

BINARY CODE—composed of a combination of entities, each of which can assume one of two possible states and which is identifiable in time or space.

BIT—a quantity of intelligence which is carried by an identifiable entity and which can exist in either of two states.

CALIBRATION ACCURACY—finite degree to which a device can be calibrated. (Influenced by sensitivity, resolution, and reproducibility of the device itself and the calibrating equipment.) Usually it is expressed in percent of full scale.

CARRIER—a wave suitable for modulating by a modulating wave.

CARRIER-TO-NOISE RATIO—magnitude of the carrier to that of the noise after selection and before any nonlinear process, such as amplitude limiting and detection.

CHANNEL TELEMETERING—route required to convey the magnitude of a single telemetering measurand.

CHANNEL PULSE—represents intelligence on a channel by virtue of the modulation characteristic.

CLAMPING CIRCUIT—maintains either amplitude extremity or a waveform at a certain potential level.

CLIPPER—a device whose output is zero or a fixed value for instantaneous input amplitudes up to a certain value, but which has an output that is a function of input for amplitudes exceeding the critical value.

CLIPPER LIMITER—a device whose output is a function of the instantaneous input amplitude for a range of values lying between two predetermined limits but is approximately constant at another level, for input values above the range.

COMMUTATION SWITCH—device used to execute repetitive sequential switching.

CROSS MODULATION—of a carrier of the desired signal by an undesired signal.

CROSS TALK—interference in a given channel originating in another channel of the same system.

DECODING—process of obtaining intelligence from a code signal.

DETECTION—process by which a wave corresponding to the modulating wave is obtained in response to a modulated wave.

DEVIATION FROM LINEARITY—in percent of full scale, deviation from linearity is the maximum deviation of a curve from the most favorable straight line that can be drawn through the curve.

DEVIATION RATIO—in a frequency-modulating system, the ratio of the signal frequency to the maximum frequency of the system.

DISCRETE SAMPLING—individual samples of such long duration that the intelligence frequency response of the channel is not deteriorated by the sampling process.

DISCRIMINATOR, FREQUENCY—a device that responds only to a given set of frequencies having a particular characteristic, such as duration, amplitude, period.

DISCRIMINATOR, PULSE—a device that responds only to a pulse having a particular characteristic, such as duration, amplitude, period. The latter is also called a time discriminator.

DISCRIMINATOR, PHASE—a device in which amplitude variations are derived in response to phase variations.

DUTY FACTOR—in a pulse carrier composed of pulses that recur at regular intervals, the product of the pulse duration and the pulse repetition frequency.

END DEVICE—the final system element that responds quantitatively to the measurand and performs the final measurement operation.

ELECTRIC TELEMETERING—telemetering performed by deriving from the measurand or from an end device a quantitatively related separate electrical quantity or quantities as a translating means.

ERROR—of an indicated value is the difference between the indicated value and the true value of the quantity measured. (It is the quantity which algebraically subtracted from the indicated value gives the true value. A positive error denotes that the indicated value of the instrument is greater than the true value.) Usually expressed in percent of full scale.

FRAME—one cycle of a cyclically recurring number of pulses.

FRAME FREQUENCY—the number of frames per unit time.

FRAME SYNCHRONIZING PULSE—a recurrent signal establishing each frame.

FREQUENCY DEVIATION—the deviation in frequency from its assigned value.

FREQUENCY MODULATION—angle modulation in which the instantaneous frequency of a sine wave carrier is caused

GLOSSARY OF TELEMETERING TERMS

(continued)

to depart from the carrier frequency by an amount proportional to the instantaneous value of the modulating wave.

FREQUENCY MODULATION DEVIATION—peak difference between the instantaneous frequency of a modulated wave and the carrier or reference frequency.

FREQUENCY MULTIPLEX—technique for the transmission over a common path of two or more signals, each characterized by a distinctive reference frequency or frequency band.

FREQUENCY RESPONSE CHARACTERISTIC—variation with frequency of the gain or loss of a device or a system.

FREQUENCY SHIFT KEYING—that form of frequency modulation in which the modulating wave shifts the output frequency between predetermined values and the output wave is coherent with no phase discontinuity.

FREQUENCY SWING—in frequency modulation, the peak difference between the maximum and the minimum values of the instantaneous frequency.

FRICTIONAL ERROR—as applied to pickups, is the difference in values measured in percent of full scale before and after tapping, with the measurand constant.

HARTLEY—a unit of information content, equal to one decimal decision, or the designation of one of ten possible and equally likely values or states of anything used to store or convey information. A Hartley may be conveyed by one 10-ary code element. One Hartley equals $\log_2 10$ bits; ($\log_2 10 = 3.323$).

HYSTERESIS ERROR—the maximum difference in percent of full scale in readings obtained by making a complete full-scale cycle of the measurand at a specific value of the latter.

INDICATOR—an instrument that makes information available but in which there is no provision for storage of such information.

INDICATION—the display to the human senses of information concerning the measurand.

INTERFERENCE—in a signal transmission system interference is the extraneous power that tends to interfere with the reception of the desired signals.

KEYING—forming of signals such as those employed in telegraph transmission by an abrupt modulation of the output of a direct-current or an alternating-current source, as, for example, by interrupting it or by suddenly changing its amplitude or frequency or some other characteristic.

LIMITER—a device whose output is virtually constant for all inputs above a critical value.

LINEARITY—a relationship existing between two quantities when the change in one quantity is exactly and directly proportional to the change in the other quantity.

MEASURAND—a physical quantity, property, or condition that is to be measured.

MODULATION—the process or the result of the process in which the amplitude, frequency, or phase of a wave is varied with time in accordance with a wave.

MODULATION INDEX—a measure of the degree of modulation for any type of modulation.

MULTIPLE MODULATION—a succession of processes of modulation in which the modulated wave from one process becomes the modulating wave for the next.

NATURAL FREQUENCY—frequencies of a body or system are the frequencies of free oscillation.

NOISE—any electrical disturbance tending to interfere with normal reception of a transmitted signal.

PHASE DEVIATION—peak difference between the instantaneous angle of the modulated wave and the angle of the carrier.

PHASE MODULATION—angle modulation in which the angle of a sine wave carrier is caused to depart from the carrier angle by an amount proportional to the instantaneous value of the modulating wave.

PHASE RESPONSE CHARACTERISTIC—the phase displacement versus frequency properties of a network or system.

PICKUP—a device that converts a magnitude (which may be of a measurand) into a corresponding electric signal.

PRIMARY DETECTOR—the first system element or group of elements that responds quantitatively to the measurand and performs the initial measurement operation.

RECORDER—an instrument for the storage of information concerning the relationship among variables.

RIPPLE—percent ripple is the ratio of the effective root-mean-square value of the ripple voltage to the average value of the total voltage, expressed in percent.

SAMPLE, INTELLIGENCE—part of a signal used as evidence of the quality of the whole.

SIGNAL—in telemetering, is the electrical intelligence or message conveyed.

SIGNAL-TO-NOISE RATIO—the ratio of the magnitude of the signal to that of the noise. This ratio is often expressed in decibels.

SUBCARRIER—a carrier applied as a modulating wave to modulate another carrier.

SYNCHRONISM—the phase relationship between two or more periodic quantities of the same period when the phase difference between them is zero.

TELEMETERING—measurement with the aid of intermediate means that permit the measurement to be interpreted at a distance from the primary detector. The distinctive feature of telemetering is the nature of the translating means, which includes provision for converting the measurand into a representative quantity of another kind that can be transmitted conveniently for measurement at a distance. The actual distance is irrelevant.

TIME DIVISION MULTIPLEX—the process of transmitting two or more signals over a common path by using different time intervals for different signals.

Bibliography

SYSTEMS

"The Theory and Application of FM/FM Telemetering", Bendix Aviation Corporation, Pacific Div., Hollywood, Calif.

"Fundamentals of Instrumentation For The Industries", Minneapolis-Honeywell Regulator Co., Ind. Div., Philadelphia, Pa.

A. L. Thurston, Scale Weighs Moving Trucks, ELECTRONICS, p 142, Jan. 1956.

A. S. Locke, "Guidance", D. Van Nostrand Co., Inc., 1955.

J. E. Spooner, Range and Coverage Characteristics of a High Capacity PTM-AM Telemetering System, *Nat Tele Conf Rec*, p 70, 1955.

H. A. Rhodes and R. W. Ralston, Channels for Telemetering, Supervisory Control and Other Purposes, *Nat Tele Conf Rec*, p 33, 1955.

C. R. Reid, A Digital Approach to Telemeter Testing, *Nat Tele Conf Rec*, p 145, 1955.

J. Prast, S. H. Calhoun, G. S. Hartloff and G. W. Liske, A Precision Pressure Telemetering System with Digital Data Handling, *Nat Tele Conf Rec*, p 192, 1955.

J. W. Poliseo, Radar Beacon Telemeter, *Nat Tele Conf Rec*, p 156, 1955.

J. Ohman, Vibrotron Digital Telemetering System, *Nat Tele Conf Rec*, p 49, 1955.

J. Mass, An Incremental Remote Position Control System, *Nat Tele Conf Rec*, p 9, 1955.

T. B. Jackson, A Sequential Pulse Telemetering System, *Nat Tele Conf Rec*, p 169, 1955.

R. F. Hummer, R. M. McClung and D. J. Simmonds, An Automatic Digital Telemetering System for Small Guided Missiles, *Nat Tele Conf Rec*, p 201, 1955.

M. H. Goldstein, Jr. and C. W. Merriam III, Evaluation of an Automatic Landing System for Aircraft, *Nat Tele Conf Rec*, p 149, 1955.

W. H. Eggerton, A 14-Channel System for Remote Control of Aircraft Flight, *Nat Tele Conf Rec*, p 161, 1955.

G. E. Earhart and O. A. Becklund, Silicon Transistor Applications in Telemetering Equipment, *Nat Tele Conf Rec*, p 174, 1955.

J. J. Dover, Telemetry as a Flight Test Instrument, *Nat Tele Conf Rec*, p 75, 1955.

L. R. Davis, A Pulse Telemetering System for Use on Balloon-Launched Rockets, *Nat Tele Conf Rec*, p 165, 1955.

Rain Gages Send Radio Reports, ELECTRONICS, p 186D, Sept. 1955.

S. S. Bagno, Designing Ultrasonic Alarm Systems, ELECTRONICS, p 106, Aug. 1955.

J. S. Carroll, S. B. Hammond and E. H. Stewart, Measuring and Recording Atmospheric Electrostatic Potentials, *Elec Eng*, p 690, Aug. 1955.

C. W. Smith and M. E. Forrest, Jr., A Fully Selective Telemetering System Employing Telegraph Facilities, *Comm and Elec*, p 372, July 1955.

W. E. Rufleth, Facts that Influence Your Approach to Telemetering, *Control Eng*, p 48, July 1955.

F. R. Park, Microwave System Controls Fog Alarm, ELECTRONICS, p 122, July 1955.

K. G. Parthemore and R. A. Spraker, Backseat Computor Rates Fuel in Action, *Control Eng*, p 58, June 1955.

G. E. Bower and J. B. Wynn, Jr., Antenna System for Missile Telemetering, ELECTRONICS, p 164, June 1955.

Joint Committee on Telemetering Terminology, Glossary of Some Telemetering Terms, *Elec Eng*, p 153, Feb. 1955.

H. J. Strickland, Light-Beam Telemetering, ELECTRONICS, p 135, Dec. 1954.

Handbook of Measurement and Control, *Instruments and Automation*, Dec. 1954.

M. L. Greenough and C. C. Gordon, Parachute-Borne Telemetering System, ELECTRONICS, p 148, June 1954.

G. M. Burgwald and L. Reiffel, Balloon-Borne Radiation Telemetering System, ELECTRONICS, p 138, May 1954.

Rawinsonde Probes Troposphere, ELECTRONICS, p 196D, Apr. 1954.

F. M. Riddle, Transistors in Telemetry, ELECTRONICS, p 178, Jan. 1954.

C. W. Johnstone, J. F. Kalback and H. J. Lang, A Telemetering System for a Large Electrostatic Accelerator, *Proc IRE*, p 1,664, Dec. 1952.

A. J. Hornfeck and G. R. Markow, Multipoint Telemetering System Using Teletype Transmission, *Elec Eng*, p 929, Oct. 1952.

J. L. McLucas, Narrow-Band Link Relays Radar Data, ELECTRONICS, p 142, Sept. 1952.

V. E. Suomi and E. W. Barrett, Experimental Radiosonde for the Investigation of the Distribution of Water Vapor in the Stratosphere, *R Sci Instr*, p 272, June 1952.

J. B. Wynn, Jr. and S. L. Ackerman, Guided Missile Test Center Telemetering System, ELECTRONICS, p 106, May 1952.

Telemetering Standards for Guided Missiles, Research and Development Board, Dept. of Defense, Nov. 1951.

A. A. McKenzie, Automatic Broadcast Program Monitor, ELECTRONICS, p 124, Oct. 1951.

J. V. L. Hogan and J. W. Smith, Multiplexed Broadcast Facsimile, ELECTRONICS, p 97, Oct. 1951.

C. K. Duff, Choice of Telemetering Systems and Channels for a Power System, *Elec Eng*, p 796, Sept. 1951.

F. Friswold, Central Instrumentation Widens Testing Scope, *Product Eng*, p 168, Aug. 1951.

M. A. Pomerantz, Cosmic-Ray Radiosonde and Telemetering System, ELECTRONICS, p 88, Apr. 1951.

J. T. McNaney, Automatic GCA, ELECTRONICS, p 82, Feb. 1951.

J. A. Doremus, Telemetering System for Radioactive Snow Gage, ELECTRONICS, p 89, Feb. 1951.

M. H. Nichols and L. L. Rauch, Radio Telemetry, *R Sci Instr*, p 1, Jan. 1951.

J. P. Chisholm, E. F. Buckley and G. W. Farnell, A Multichannel PAM-FM Radio Telemetering System, *Proc IRE*, p 36, Jan. 1951.

W. A. Derr, T. C. Wren and J. V. Kresser, Multistation Supervisory Control, Telemetering and Communication of Single-Frequency Carrier Channel, *Elec Eng*, p 862, Oct. 1950.

G. E. Foster, The Metrotype System of Digital Recording and Telemetering, *Elec Eng*, p 427, May 1950.

Telemetering Ocean Current Information, ELECTRONICS, p 148D, Mar. 1950.

F. W. Lehman, Transistor Oscillator for Telemetering, ELECTRONICS, p 90, Aug. 1949.

A. A. McKenzie, Ultrafax, ELECTRONICS, p 77, Jan. 1949.

P. A. Borden and G. M. Thynell, "Principles and Methods of Telemetering", Reinhold Pub. Corp., New York, N. Y., 1948.

R. E. Belin, Radiosonde Potential Gradient Measurements, ELECTRONICS, p 184D, Jan. 1948.

Telemetering, Supervisory Control and Associated Circuits, Special Pub. S-12, *AIEE*, 1948.

V. L. Heeren, C. H. Hoeppner, J. R. Kauke, S. W. Lichtman and P. R. Shifflett, Telemetering from V-2 Rockets, Part II, ELECTRONICS, p 124, Apr. 1947.

V. L. Heeren, C. H. Hoeppner, J. R. Kauke, S. W. Lichtman and P. R. Shifflett, Telemetering from V-2 Rockets, Part I, ELECTRONICS, p 100, Mar. 1947.

Telemetering in Stratosphere, ELECTRONICS, p 142D, Mar. 1947.

L. L. Rauch, Electronic Communication for Telemetering, ELECTRONICS, p 114, Feb. 1947.

L. Ackerman and George Rappaport, Radio Control Systems for Guided Missiles, ELECTRONICS, p 86, Dec. 1946.

D. W. Moore, Jr., Plane-to-Ground Radio Telemetering, ELECTRONICS, p 124, Nov. 1945.

Facsimile Over 4,000-Mc Relay System, ELECTRONICS, p 146D, Oct. 1946.

H. B. Brooks, Weather Forecasting, ELECTRONICS, p 84, Oct. 1946.

N. J. Holter, Measurement of Ocean Waves Generated by Atomic Bombs, ELECTRONICS, p 94, May 1946.

V. D. Hauck, J. R. Crosby and A. B. Dember, Radiosonde Telemeter Sytems, ELECTRONICS, p 120, May 1946.

K. Henney, The Sonobuoy, ELECTRONICS, p 154, Apr. 1946.

P. J. Herbst, I. Wolff, D. Ewing and L. F. Jones, The Teleran Proposal, ELECTRONICS, p 124, Feb. 1946.

TRANSDUCERS

L. A. G. TerVeen, New Development in Miniature Telemetering Pickups, *Nat Tele Conf Rec*, p 63, 1955.

R. A. Runyan and J. B. Harry, A. Capacitance Compensated Strain Gage Subcarrier Oscillator, *Nat Tele Conf Rec*, p 88, 1955.

R. L. Rod, Ultra Sonic Liquid Level Indicating Systems, *Nat Tele Conf Rec*, p 28, 1955.

S. C. Stern and C. W. Hill, Simple Ultraviolet Radiometer, *R Sci Instr*, p 1,222, Dec. 1955.

S. A. Davis, Using A Two-Phase Servomotor as an Inductor Tachometer, *Control Eng*, p 75, Nov. 1955.

A. D. Maier, Tap the Transducer to Up System Accuracy, *Control Eng*, p 92, Oct. 1955.

S. R. Gilford and H. P. Broida, Physiological Monitor for Anesthesia, ELECTRONICS, p 130, Oct. 1955.

R. E. Bell, Electric Transducers for Automatic Weighing, *Elec Eng*, p 926, Oct. 1955.

A. J. Hornfeck and L. M. Wermelskirchen, The Movable Core Transformer as a Pick-up for Industrial Telemetering Systems, *Comm and Elec*, p 454, Sept. 1955.

V. B. Corey, Calibrate Angular Accelerometers Without Precise Accelerations, *Control Eng*, p 87, Aug. 1955.

H. F. Clarke, A Survey of Noncontacting Vibration Pickups Using Electric Fields, *Comm and Elec*, p 186, May 1955.

W. H. Howe, High-Pressure Measurement and Control, *Control Eng*, p 53, Apr. 1955.

H. M. Joseph and N. Newman, Eddy-Current Mutual-Inductance-Transducers with High-Conductivity Reference Plates, *Comm and Elec*, p 39, Mar. 1955.

W. R. Clark, W. G. Amey and G. C. Mergner, An Air-borne Temperature Indicator, *Comm and Elec*, p 1, Mar. 1955.

H. Christensen and J. E. Funder, Pressure Gage for Ship-Model Hulls, ELECTRONICS, p 196D, Jan. 1955.

Characteristics and Applications of Resistance Strain Gages, National Bureau of Standards, Washington, D. C., 1954.

R. L. Bailey and J. B. Quirk, VHF Meter Measures Low Power Levels, ELECTRONICS, p 158, Nov. 1954.

H. B. Weisbecker and R. Steinitz, Direct-Reading Grenz-Ray Dosimeter, ELECTRONICS, p 168, Oct. 1954.

F. Rockett, Precision Potentiometers Use New Materials, ELECTRONICS, p 145, Oct. 1954.

J. Piccard, H. Larsen and J. Blomstrand, Thin Wire Thermometer for Radiosondes, *R Sci Instr*, p 959, Oct. 1954.

R. J. Levine, Temperature-Compensated Aircraft Fuel Gage, ELECTRONICS, p 160, Sept. 1954.

E. Keonjian and J. S. Schaffner, Shaping of the Characteristics of Temperature-Sensitive Elements, *Comm and Elec*, p 396, Sept. 1954.

A. Corman and J. F. Bedinger, Rocket-Borne Photometer Measures Sky Light, ELECTRONICS, p 151, Sept. 1954.

G. C. Mayer, Electrical Circuits for

Weight Measurement, *Elec Mfg*, p 80, Aug. 1954.

J. Krog, Improved Needle Thermocouple for Subcutaneous and Intramuscular Measurements in Animals and Man, *R Sci Instr*, p 799, Aug 1954.

V. A. Orlando, A Transducer Using A Short-Circuit Rotor, *Comm and Elec*, p 131, May 1954.

D. B. Kret, "Transducers", Allen B. Du Mont Lab., Inc., Instr. Div., Clifton, N. J., 1953.

E. Jones, Cemented Piezoelectric Accelerometers, *R Sci Instr*, p 1,151, Dec. 1953.

D. Steen and D. Casey, Theory of the Manometer Accelerometer, *R Sci Instr*, p 1,021, Nov. 1953.

S. Davis, Rotating Components for Automatic Control, *Product Eng*, p 129, Nov. 1953.

A. L. Brownlee and H. E. Brown, Generator Stator Copper Temperature Indicator, *Comm and Elec*, p 676, Nov. 1953.

J. E. Dinger and R. E. Ruskin, Resistance Thermometer with a Linear Response, *R Sci Instr*, p 761, Sept. 1953.

L. C. Bradley, Temperature Sensitive Phosphor Used to Measure Surface Temperatures in Aerodynamics, *R Sci Instr*, p 219, Mar. 1953.

H. V. Neher, Barometer Element for Radio-Sondes, *R Sci Instr*, p 97, Feb. 1953.

J. Winckler and K. Anderson, An Improved Cerenkov Detector for Cosmic Rays, *R Sci Instr*, p 765, Dec. 1952.

C. M. Fields and R. S. Nevin, Sinusoidal Calibration Table for Vibration Type Transducers, *Product Eng*, p 172, Dec. 1952.

R. J. Fyffe and A. Arobone, Strain Gage Transducers for Measurement and Control, *Product Eng*, p 121, Nov. 1952.

G. K. Guttwein and A. I. Dranetz, Self-Generating Accelerometers, ELECTRONICS, p 120, Oct. 1951.

H. H. Schwartz, Capacitor Gages for Measuring Small Motions, *Product Eng*, p 163, Aug. 1951.

H. W. Cole, Jr., Some Thermocouple Details for Temperature Measurement, *Product Eng*, p 166, Aug. 1951.

Testing Aircraft Fuel Gages, ELECTRONICS, p 138D, July 1951.

S. B. Haynes, Automatic Calibration of Radiosonde Baroswitches, ELECTRONICS, p 126, May 1951.

J. F. Engelberger and H. W. Kretsch, An Electromechanical Transducer, *Elec Eng*, p 437, May 1951.

S. A. Talbot, J. L. Illienthal, Jr., J. Besser and L. W. Reynolds, Wide Range Mechano-Electronic Transducer For Physiological Applications, *R Sci Instr*, p 233, Apr. 1951.

H. R. Bierman and R. Jenkins, Hypodermic Pressure Manometer Utilizing the Bonded Wire Resistance Strain Gauge, *R Sci Instr*, p 268, Apr. 1951.

D. J. DeMichele, Wire Strain Gages for Elevated Temperature Service, *Product Eng*, p 115, Oct. 1950.

T. R. Breunich, Sensing Small Motions with Variable Reactors and Differential Transformers, *Product Eng*, p 113, July 1950.

W. D. MacGeorge, The Differential Transformer as Applied to the Measurement of Substantially Straight Line Motions, *Instruments*, p 610, June 1950.

Permanent Magnet Measures Fluid Flow, *Product Eng*, p 98, Feb. 1950.

Special Magnetometer Developed at NOL, *Product Eng*, p 150, Jan. 1950.

R. C. Hizer, Testing Vehicle Components With Strain Gages, *Product Eng*, p 134, Apr. 1949.

D. E. Weiss, Instrument for Measurement of Angular Accelerations, *Product Eng*, p 87, Feb. 1949.

A. C. Ruge, Bonded Resistance Wire Gage for Strain Measurements, *Product Eng*, p 116, Jan. 1949.

C. S. Franklin, Precise Measurement of Aircraft Speed, ELECTRONICS, p 72, Feb. 1948.

E. F. Kiernan, Telemetering Fathometer, ELECTRONICS, p 96, Oct. 1947.

F. J. Curran, Impedance Bridge for Flow-Rate Metering, ELECTRONICS, p 106, Apr. 1947.

D. W. Moore, Jr., Electronic Position Pickup, ELECTRONICS, p 100, Jan. 1947.

D. G. Fink, F-M Radar Altimeter, ELECTRONICS, p 130, Apr. 1946.

D. W. Moore, Jr., Fuel Consumption Indicator, ELECTRONICS, p 152, Mar. 1946.

M. E. Kennedy, Remote Water Indicators, ELECTRONICS, p 130, Feb. 1945.

CODING OR SAMPLING

H. Moss, The Magnetron Beam Switching Tube, *Nat Tele Conf Rec*, p 97, 1955.

R. O. DuBois, Miniaturized Airborne Electronic Commutator, *Nat Tele Conf Rec*, p 112, 1955.

W. R. Davis, High Speed Mercury Jet Commutating Switch, *Nat Tele Conf Rec*, p 105, 1955.

J. F. Brinster, Mechanical Sampling Devices in Telemetering and Related Fields, *Nat Tele Conf Rec*, p 44, 1955.

W. R. Davis and J. H. Derry, Quicksilver Quickens Telemetering Switch's Sampling Pace, *Control Eng*, p 84, June 1955.

A. G. Fitzpatrick, PCM Coding System Uses Special Tubes, ELECTRONICS, p 173, Nov. 1953.

R. R. Bennett and H. Low, Step Switch Converter Digitizes Analog Data, ELECTRONICS, p 164, Nov. 1953.

U. C. Gupta and R. Parshad, Relay-Operated Two-Channel Commutator Switch, *R Sci Instr*, p 833, Sept. 1953.

J. P. Costas, Coding with Linear Systems, *Proc IRE*, p 1,101, Sept. 1952.

W. H. Chester and W. P. Klemens, Decommutating Pulse Telemetry, ELECTRONICS, p 140, Aug. 1952.

SIGNALING

R. W. White, A PDM-FM Telemeter for Low Level DC Inputs, *Nat Tele Conf Rec*, p 78, 1955.

R. M. Stuart, A New Hi-Speed Telemetet Transmitter for DC Measurements, *Nat Tele Conf Rec*, p 5, 1955.

G. S. Sloughter, R. A. Runyan, W. H. Duerig, and G. E. Tisdale, Telemetry Filters and Their Effect on the Dynamic Accuracy of Multiplex FM Subcarrier Instrumentation Systems, *Nat Tele Conf Rec*, p 118, 1955.

M. S. Redden, Jr. and H. W. Zancanata, A New Crystal-Controlled Ground-Station Telemetering Receiver, *Nat Tele Conf Rec*, p 127, 1955.

W. F. Link, Mixing Airborne Telemetering Subcarriers for Maximum Isolation with Minimum Loss, *Nat Tele Conf Rec*, p 123, 1955.

W. H. Howe, A New Time Interval Telemeter System, *Nat Tele Conf Rec*, p 15, 1955.

L. Finkel, F. Shandelman and J. Piontkowski, A New Subminiature Airborne FM Demultiplexer, *Nat Tele Conf Rec*, p 92, 1955.

J. R. Cunningham, Automatic Teletype Transmitting System, *Nat Tele Conf Rec*, p 21, 1955.

A. H. Cooper, Coherent Pulse Telemetry, *Nat Tele Conf Rec*, p 179, 1955.

G. F. Montgomery, Ultrasonic Switch Aids Diversity Reception, ELECTRONICS, p 169, Nov. 1955.

M. H. Kebby, Coaxial Cavity Filters for Multiplexing of 900-MC Radio-Relay Systems, *Elec Eng*, p 425, May 1955.

J. C. G. Carter, The Use of Tone Modulation Over Complex Carrier Channels, *Elec Eng*, p 310, Apr. 1955.

E. Weber, Telegraph Signals Meter Liquid Fluid Level, *Control Eng*, p 87, Mar. 1955.

W. J. Brown, Wide-Angle Phase Shifter for Industrial Controls, ELECTRONICS, p 188, Mar. 1955.

D. G. Mazur,. Pulse Transmitter for Rocket Research, ELECTRONICS, p 164, Nov. 1954.

H. B. Schultheis, Jr., Frequency-Code Telemetering System, ELECTRONICS, p 172, Apr. 1954.

C. R. Schafer, Phase-Selective Detectors, ELECTRONICS, p 188, Feb. 1954.

H. S. Black, "Modulation Theory", D. Van Nostrand Co., Inc., New York, N. Y., 1953.

R. W. Beckwith, Frequency Shift Carrier-Current Equipment for Telemetering and Other Control Functions, *Elec Eng*, p 1,026, Nov. 1952.

D. J. Gray, V. P. Gurske and W. E. Morrow, Wide Band Data Transmitter, ELECTRONICS, p 168, Sept. 1953.

A. L. Hopper, Nonsynchronous Pulse Multiplex System, ELECTRONICS, p 116, Aug. 1952.

F. G. Willey, Converter Circuit for Phase-Shift Telemetering, ELECTRONICS, p 140D, Aug. 1951.

G. S. Sloughter and R. Ellis, Linear Discriminator for F-M Multiplexing, ELECTRONICS, p 112, June 1951.

N. R. Best, Matrix Telemetering System, ELECTRONICS, p 82, Aug. 1950.

J. L. A. McLaughlin, Folded Sideband Modulation, ELECTRONICS, p 88, Mar. 1950.

G. H. Melton, Multichannel Radio Telemetering for Rockets, ELECTRONICS, p 106, Dec. 1948.

O. G. Villard, Jr., Composite Amplitude and Phase Modulation, ELECTRONICS, p 86, Nov. 1948.

S. Bailey and H. E. Singleton, Reducing Transmission Bandwidth, ELECTRONICS, p 107, Aug. 1948.

H. D. Helfrich, Jr., Wide Deviation Reactance Modulator, ELECTRONICS, p 120, Apr. 1948.

D. G. Fink, Bandwidth as Noise in Communications Systems, ELECTRONICS, p 72, Jan. 1948.

Effect of Modulation on Transmission Efficiency, ELECTRONICS, p 136D, Jan. 1948.

F. Rockett, Coded Pulse Modulation Minimizes Noise, ELECTRONICS, p 126, Dec. 1947.

Pulse Code Modulation, ELECTRONICS, p 136D, Aug. 1947.

F. H. Rockett, Modulation Types and Characteristics, ELECTRONICS, p 124, mid-June 1947.

A. Easton, Pulse Modulated Oscillator, ELECTRONICS, p 124, Mar. 1947.

H. K. Bradford, Wide-Angle Phase Modulator, ELECTRONICS, p 100, Feb. 1947.

O. G. Villard, Jr., Overmodulation Without Sideband Splatter, ELECTRONICS, p 90, Jan. 1947.

G. G. Bruck, Frequency Modulator, ELECTRONICS, p 166D, Jan. 1947.

M. Marks, Cascade Phase Shift Modulator, ELECTRONICS, p 104, Dec. 1946.

Pulse Time Modulation Circuits, ELECTRONICS, p 140D, Nov. 1946.

J. E. Smith, Theoretical Signal-to-Noise Ratios, ELECTRONICS, p 150, June 1946.

J. J. Kelleher, Pulse-Modulated Radio Relay Equipment, ELECTRONICS, p 124, May 1946.

D. Schulman, Facsimile Synchronizing Methods, ELECTRONICS, p 130, Mar. 1946.

DATA PROCESSING

J. L. Winget, Precision Data Recording and Repeating System (The Inductosyn), *Nat Tele Conf Rec*, p 55, 1955.

R. F. Shaw, Talking to a Computer, *Nat Tele Conf Rec*, p 190, 1955.

R. L. Kenimer, An Analog Cross-Spectrum Analyzer for Certain Telemetered Data, *Nat Tele Conf Rec*, p 82, 1955.

H. D. Grief and R. A. DeKimpe, Automatic Data Reduction of Missile Telemetering, *Nat Tele Conf Rec*, p 204, 1955.

A. V. Gangnes, Precision Multi-Channel Heads for Magnetic Tape Recording, *Nat Tele Conf Rec*, p 141, 1955.

G. L. Davies, The Role of Magnetic Tape in Data Recording Processing and Analysis, *Nat Tele Conf Rec*, p 182, 1955.

G. E. Bower, A New Instrumentation Direct Writing Recorder and Its Application to Telemetry, *Nat Tele Conf Rec*, p 138, 1955.

G. W. King, A New Approach to Information Storage, *Control Eng*, p 48, Aug. 1955.

R. L. Perkins, Magnetic Drum Storage Devices, *Product Eng*, p 192, Aug. 1955.

E. M. McCormick, Data Reduction System for Missile Telemetering, ELECTRONICS, p 126, May 1955.

G. M. Groenendyke and G. B. Loper, Cathode-Ray Display of Seismic Recordings, ELECTRONICS, p 160, May 1955.

H. B. Jones, Recording Systems, *Product Eng*, p 180, Mar. 1955.

S. J. Begun, Magnetic Tape Improves Geophysical Recordings, ELECTRONICS, p 152, Jan. 1955.

Recorder Monitors Test Flight, ELECTRONICS, p 192D, Sept. 1954.

A. S. Hoagland, Magnetic Drum Recording of Digital Data, *Comm and Elec*, p 381, Sept. 1954.

C. M. Hathaway, W. L. Davis and J. R. Curtin, A New 12-Element Automatic Oscillograph and Application on the Bonneville Power System, *Comm and Elec*, p 307, Sept. 1954.

G. L. Hollander, Digital Data-Recorder Stores Continuous Voltages, *Comm and Elec*, p 253, July 1954.

M. L. Van Doren, Magnetic Recording of PWM Signals, ELECTRONICS, p 232D, May 1954.

G. K. Guttwein and J. M. Leslie, Jr., Magnetic Recording for Vehicular Research, ELECTRONICS, p 154, Feb. 1954.

S. R. Gilford, Direct-Indicating Recording Instruments, Part II, *Elec Mfg*, p 120, Dec. 1953.

S. R. Gilford,Direct-Indicating Recording Instruments, Part I, *Elec Mfg*, p 114, Nov. 1953.

J. Linsley, Pulse Recording System for Research at High Altitude, *R Sci Instr*, p 181, Feb. 1953.

A. A. Gerlach, F-M Recording in Guided Missiles, ELECTRONICS, p 108, Jan. 1953.

L. Costrell, FM Data Reduction from Magnetic Tape Recordings, *R Sci Instr*, p 76, Jan. 1953.

W. H. Bliss, Recorder and Timer for Short Intervals, ELECTRONICS, p 126, Nov. 1947.

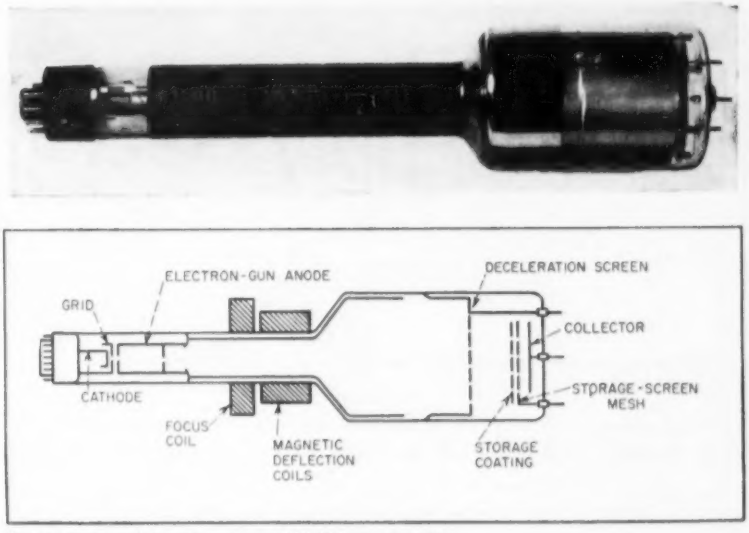
By SAUL SHENFELD

and

MANUEL FINKLE

U. S. Navy Underwater Sound Laboratory

New London, Connecticut



Appearance and structure of type QK-464 storage tube

Storage-Tube Device Simulates Radar Net

SUMMARY — Video signals are obtained in the form in which they would be received from two or more separated radar stations. Moving targets may be simulated. Cathode-ray storage tube retains information fed alternately to separate radar indicators

IN EVALUATING radar indicator equipment, the problem of synthesizing video signals, which represent the return echoes of moving targets, frequently arises. This problem may be complicated by the need for presenting the targets as they would be displayed on indicators of two or more radar stations geographically displaced.

In Fig. 1A is shown a possible configuration of the targets and two radar stations whose returns are to be simulated. The radar stations are labeled *A* and *B*. Although only three targets are shown, many more could be simulated.

Three radar indicators using ppi presentation were used. In one, the oscilloscope was replaced with a QK-464 storage tube. This indicator employed the resolved-time-base type of sweep and had provision for off-centering in the X and Y directions. The other indicators used centered ppi presentation.

Synchros

A slewing motor drove a 5G synchro at 5 rpm. The output of the synchro was connected to the servo system in each indicator so that the three indicators had identical speeds of angular rotation. The instantaneous bearing of each sweep was aligned by zeroing each synchro.

In Fig. 1B is shown the indicator presentations simulating those used for stations *A* and *B*. It is assumed that the targets and stations are in the positions shown in Fig. 1A.

To achieve the video signals for each channel, it was necessary to modify the indicator containing the storage tube so that the position of the sweep origin could be off-centered on a time-shared basis between the points on the storage tube corresponding to the locations of stations *A* and *B*.

The configuration on the screen of the storage tube is shown in Fig. 2A. Because of time-shared off-centering, one sweep will emanate from *A* and the next sweep will emanate from *B*. The sweep starting from *A* will give an electrical

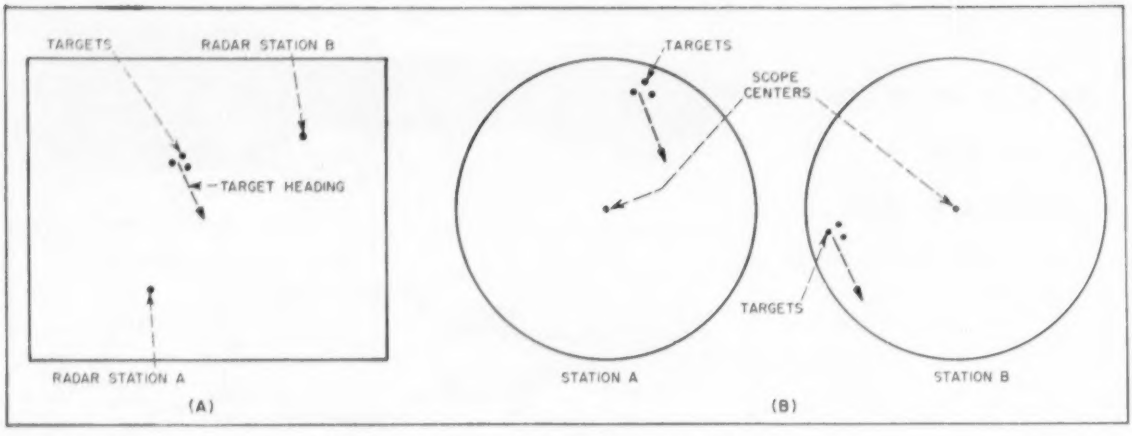


FIG. 1—Configuration of targets and radar stations (A) and simulated ppi presentations (B)

output from the storage tube as shown in Fig. 2B. The next sweep, starting from *B*, will have no echo. It is then possible to obtain video which will have bearing and range connotation of returns obtained at positions *A* and *B*.

Storing Signals

The QK-464[1,2] is an electrical-input and electrical-output storage tube. To prepare the storage surface for the WRITE operation during which the target signals are stored, it is necessary to operate the tube first in an ERASE and then in a CHARGE condition. For erasure, the storage screen is connected to +300 v and a constant beam current is scanned across the entire surface of the storage screen.

For charging, the surface of the storage screen is again scanned with a constant beam current but with the voltage of the storage screen reduced to approximately 30 v d-c.

For the WRITE operation, the storage screen is connected again to +300 v, but sufficient bias is applied to the control grid to prevent current flow except during the actual writing of the signal. With this voltage, secondary emission ratio of the storage surface is greater than unity. As a result, any electrons striking the surface will cause a greater number of electrons to leave the area. A positive potential is created at this point relative to the rest of the screen.

For writing, the 5G synchro was operated manually. The sweep was positioned along the bearing of the target with respect to A and a range strobe was used to give a sharp pip at the range of the target. See Fig. 2C. The intensity control of the range strobe was turned up for a fraction of a second to write. This sequence may be continued for writing any number of targets.

An alternative procedure consists of disabling the sweep circuits during the WRITE operation and, by X and Y positioning controls, locating the beam spot at the desired target positions. When the grid bias of the tube is reduced for a fraction of a second, the target positions may be marked. The sweep is then restored to normal operation.

Read Out

For reading out the stored information, the potential on the storage screen is reduced to approximately +20 v. The beam current is set for a few microamperes.

Electrons will reach the collector plate only at those points which were written positively during the WRITE cycle. If the sweep starts at point *A*, target pips will be obtained only when the sweep line crosses the positively charged spot area. The time of occurrence along a sweep line will depend upon the time necessary for the sweep to move from its start to the location of the target.

This procedure will give video signals corresponding to the radar returns detected by a radar station located at *A*. The start of each second sweep may be displaced to the location of *B*. This is accomplished by time-shared gates, which provide off-centering potentials on an every-other-sweep basis. See Fig. 3.

The input that triggers the sweep gate is applied to a flip-flop. The output of the flip-flop is connected to off-centering clamps that determine the magnitudes of the off-centering voltages. The gates from the flip-flop determine whether the *A* or the *B* off-centering clamp is activated. The amount of the X and

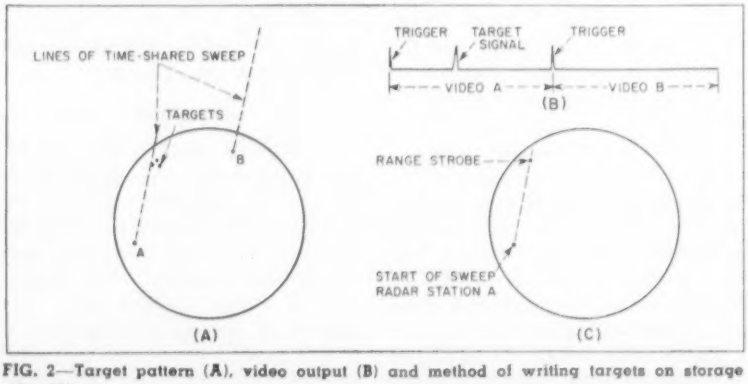


FIG. 2—Target pattern (A), video output (B) and method of writing targets on storage tube (C)

Y off-centering is determined by potentiometers that set the d-c potentials on the clamping tube.

The output gates of the flip-flop are connected to gated video amplifiers. The video output from the gated video *A* channel occurs when the sweep is off-centered to correspond to position *A*. This sequence occurs for one sweep line. The start of the next sweep on the storage tube occurs from position *B*, and the gated video *B* amplifier is activated.

The video connected to indicator *A* will show the targets as seen from *A*. On the other indicator the targets will be displayed as though detected from *B*. A schematic diagram of the output circuits of the storage tube, the video amplifier and the gated video amplifiers is shown in Fig. 4.

A simulation of moving targets has been devised by connecting points *X* and *Y* in Fig. 3, to a non-time-shared, variable d-c voltage. This may be obtained from a motor-driven potentiometer and adds a variable displacement to both time-shared off-centered voltages. The targets though fixed in location on the screen, will actually appear on indicators *A* and *B* as moving targets. This is due to the translation of the centers of both sweeps.

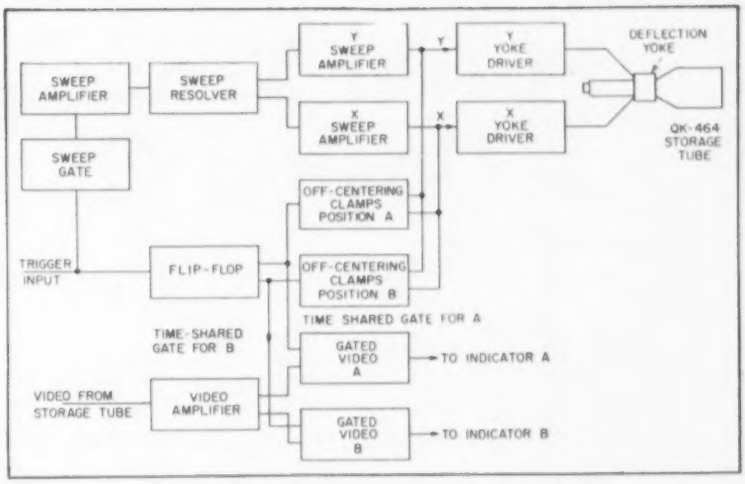


FIG. 3—Time-shared sweep permits alternate display on two radar indicators

The authors acknowledge the cooperation of A. S. Luftman and J. Buckbee of Raytheon Manufacturing Company, who assisted in the technical problems concerned with optimum preformance of the storage tube.

References

(1) R. C. Hergenrother and B. C. Gardner, The Recording Storage Tube, *Proc IRE*, **38**, p 740, July 1950.

(2) S. Winkler and S. Nozick, Operation of CRT Storage Devices, ELECTRONICS, **27**, No. 10, p 184, Oct. 1954.

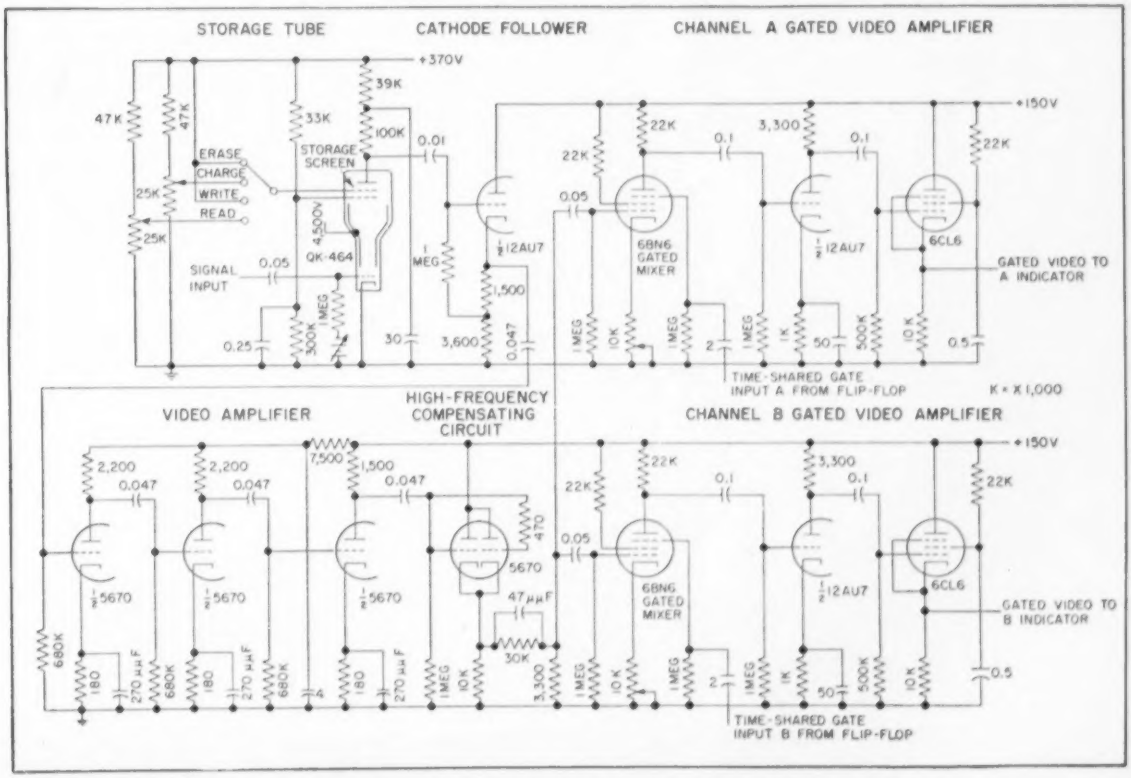


FIG. 4—Storage tube circuits, video amplifier and gated video circuits constitute heart of radar simulator

Power Transformer Design Charts

By REUBEN LEE and N. E. MULLINIX

Westinghouse Electric Corp.
Baltimore, Md.

SUMMARY —— Design time for two-winding, 60-cps power transformers is reduced by charts based on use of specific core series under typical operating conditions. Data is also useful as starting point in more complex designs

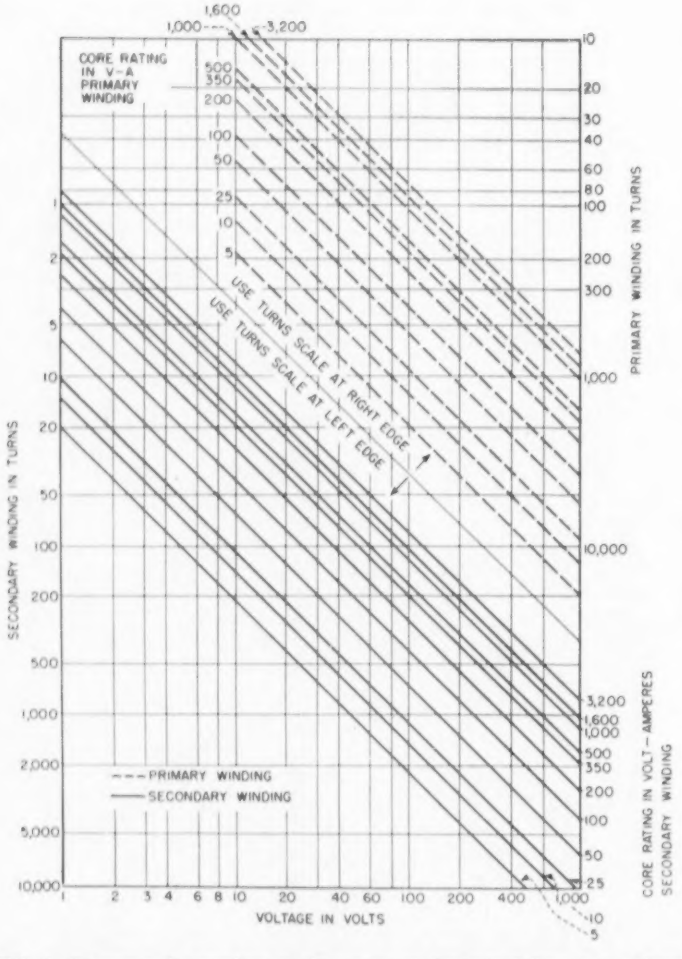


FIG. 1—Primary and secondary winding turns as determined from core volt-ampere rating

DESIGN of simple, low-voltage transformers creates a problem for most transformer design groups. These design charts eliminate or minimize the amount of calculation necessary.

Chart Design Conditions

Limiting assumptions had to be made so that the values for the chart could be calculated. These were based on the use of type-C cores but a similar chart could be made for any given series of cores at 60 cps or other frequencies. The assumptions were:

(1) The core is used at maximum rated volt-amperes.

(2) Core flux density is 16,500 gauss at 60 cps.

(3) The transformer is a single-section secondary wound over primary with 1,000-volt insulation throughout.

(Continued on page 186)

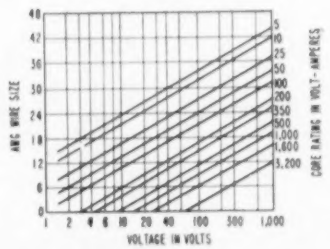


FIG. 2—Winding wire size in relation to voltage and core rating

NEW

Compression type—28, 32, 40, 48 and 52 contact connectors. Center engaging screw with wing nut or screw driver slot and spring action contacts—permits easy, quick and reliable engagement and dis-engagement. Receptacle side available for pressurized applications.

40 contact connector "A" style for applications where plug is "live voltage" side.

CINCH MICRO CONNECTORS

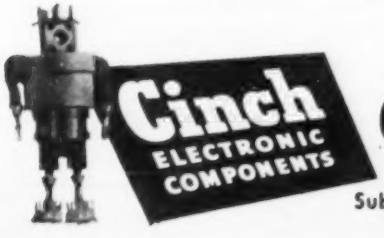
Available in two styles for alternate application where either the plug or receptacle side is the "live" voltage side. (Protective Hoods and Cable Clamps Available.)

52 contact connector "B" style for applications where receptacle is "live voltage" side.

Molded of orlon filled diallyl per MIL-P-14D. Contacts gold plated; other hardware is passivated stainless steel. (Multiple polarization available.)

Cinch will design, or re-design components to fit specific needs, and will assist in the assembly of components through proven automation technique.

Centrally located plants in Shelbyville, Chicago, Pasadena, St. Louis.



CONSULT CINCH

CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

Power Transformer Design Charts

(Continued from page 184)

(4) Primary and secondary windings occupy equal amounts of space. Total coil height occupies nine-tenths of core-window height.

(5) Copper loss is divided equally between the two windings.

(6) Total transformer temperature rise is 40 C with a 65 C ambient except for the four smallest cores. These were limited by the regulation values shown in Table 1.

(7) All units are uncased, vacuum impregnated with resin.

Procedure in using the design charts is as follows:

(1) Choose a core from Table I which has a v-a rating equal to or greater than that required.

(2) Using rated primary and secondary voltages, find number of turns for both windings from Fig. 1.

(3) From rated primary and secondary voltages, find wire size for both windings from Fig. 2.

(4) Use the chart of Fig. 3 to obtain winding resistances.

Ratings rarely fall exactly on the v-a values assigned to each core. Therefore, choose the core with the next higher rating. Wire size in Fig. 2 also increases in discrete sizes. If the chart indication falls between two sizes the smaller size should be used.

Departures from the assumed conditions preclude direct use of the chart, but it is still useful as a starting point in designing transformers for high voltages or with multiwinding secondaries. The following notes apply to such modifications:

(1) For each additional secondary winding reduce the core maximum rated volt-ampere by 10 percent.

(2) For 5-kv rms working voltage reduce the core maximum rated volt-amperes approximately 33 percent.

(3) For 50/60-cycle transformers, reduce the core maximum rated volt-amperes 10 percent.

(4) When permissible temperature rise is higher than 40 C, the core maximum volt-amperes equals (v-a in table) $\times$ $\sqrt{\text{temperature rise}/40\ \text{C}}$.

(5) For rectifier plate transformers use the average of primary and secondary volt-amperes to determine core size. Multiply the primary-wire size in circular mils on chart by primary v-a/average v-a, and secondary wire in circular mils by secondary v-a/average v-a.

(6) When taps are required, additional layers of wire may be needed, and unless the transformer rating falls well below the maximum core rating in Table I, size is larger than for a transformer with no taps.

Figure 4 gives the relationship between wire size and current for various cores.

Table I—Core Size, Rating and Regulation

Core	Maximum V-A Rating	Per Cent Regulation	Total Wt in lb	Overall Size in Inches
1	5	15	0.38	$1\frac{3}{4} \times 1\frac{3}{4} \times 1\frac{3}{4}$
2	10	15	0.68	$1\frac{7}{8} \times 2\frac{3}{8} \times 1\frac{3}{4}$
3	25	10	1.2	$2\frac{1}{4} \times 2\frac{7}{8} \times 2\frac{1}{4}$
4	50	10	2.2	$2\frac{1}{2} \times 3\frac{1}{8} \times 2\frac{1}{2}$
5	100	8	3.8	$3\frac{1}{8} \times 3\frac{3}{4} \times 3$
6	200	6	6.4	$3\frac{7}{8} \times 4\frac{3}{4} \times 3\frac{5}{8}$
7	350	4	11.0	$4\frac{3}{8} \times 5\frac{3}{8} \times 4$
8	500	3	15	$5\frac{1}{8} \times 6\frac{1}{8} \times 5$
9	1,000	2.2	24	$5\frac{7}{8} \times 6\frac{3}{4} \times 6\frac{1}{8}$
10	1,600	1.8	36	$7\frac{1}{4} \times 8\frac{1}{4} \times 7\frac{1}{2}$
11	3,200	1.2	75	$9\frac{3}{4} \times 12\frac{3}{4} \times 8$

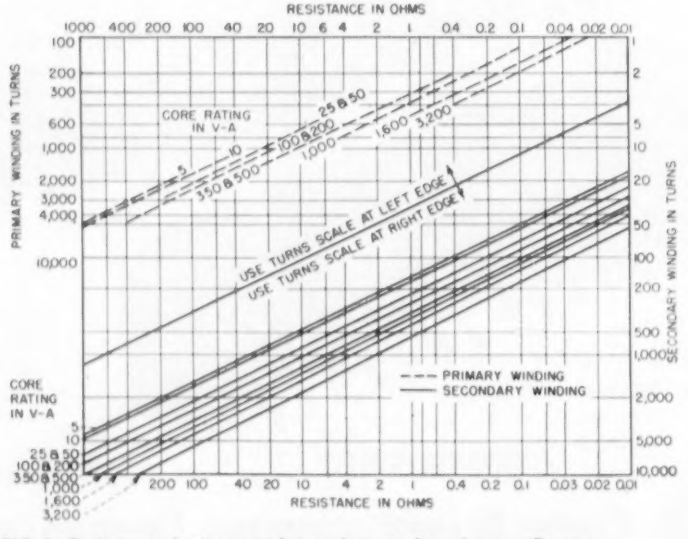


FIG. 3—Resistance of primary and secondary windings for type-C cores

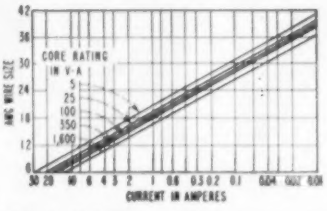


FIG. 4—Relation of winding wire size to current

Condensed by permission from "Electronic Transformers and Circuits" 2nd Edition, by Reuben Lee, John Wiley & Sons, Inc., N. Y.

MALLORY

MALLORY MERCURY BATTERIES

Mallory Mercury Batteries and Silverlytic® Capacitors save space, provide superior performance in transistor circuits and other low-voltage miniature equipment.

SILVERLYTIC CAPACITORS

Dependability in Miniature Size —to Work with Transistors

To power transistor circuits, Mallory Mercury Batteries are now manufactured by a unique "snap together" construction† that makes higher voltage ratings available at hourly operating costs even lower than conventional batteries. The new design comes in standard 15, 22½ and 45 voltages . . . can be produced in other ratings on order. A unique power source pioneered by Mallory, mercury batteries offer high energy content in small volume . . . far longer life in service and in storage. Service life up to three times that of usual dry batteries can be expected in transistor radios. Their constant discharge characteristic is ideally suited for transistor operation.

Subminiature Silverlytic Capacitors give maximum rating in small size. Type TAP, $\frac{7}{32}$" in diameter by $\frac{3}{8}$" long, operates from −55° to +85° C; values up to 30 mfd. at 6 volts, and in higher voltages as well. Even smaller is Type TAW—only .145" in diameter by $\frac{3}{8}$" long. Five basic capacitance values for Type TAW, from 1 mfd. at 24 volts to 6 mfd. at 4 volts. Each capacitance value is also available at lower voltage ratings at slightly lower cost.

We'll be glad to consult on your specific circuit requirements, and to send full technical data. Just write or call Mallory today.

*®Trademark

†Patent applied for

Parts distributors in all major cities stock Mallory standard components for your convenience.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Tuning Devices • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Expect more . . . get more from

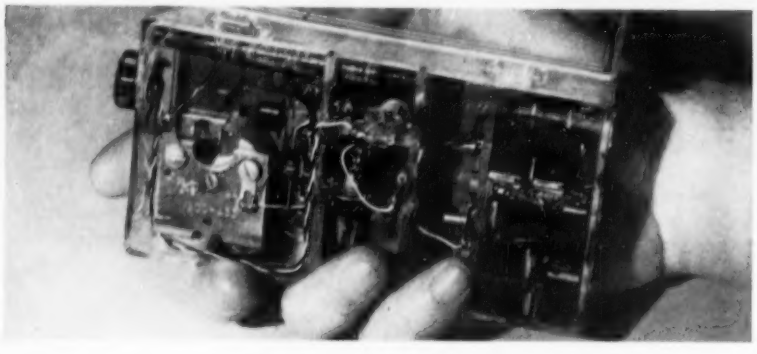
P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Want more information? Use post card on last page.

Electrons At Work

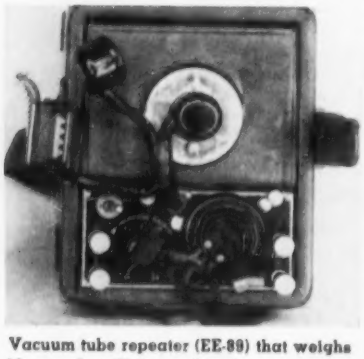
Edited by ALEXANDER A. McKENZIE

Transistor Receiver Powered By Sun

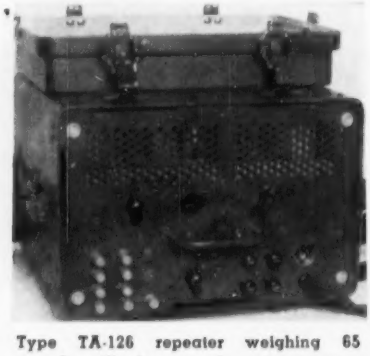


Weighing only 10 ounces, the receiver shown is said by General Electric engineers to be capable of working two hours a day for more than eight months in total darkness although solar powered. A miniature storage battery is charged by seven solar cells contained in the transparent plastic case. Artificial light, like that from a 100-watt bulb, can be used to operate the experimental receiver in the absence of daylight. Costs are still too high to contemplate use of highly efficient solar cells for production receivers. Size of the unit could be cut in half by substituting new subminiature components. Four *npn* transistors are used

Army's First Semiconductor Equipment



Vacuum tube repeater (EE-89) that weighs 16 pounds will be replaced



Type TA-126 repeater weighing 65 pounds will give way in some cases

ENGINEERING models of Signal Corps first fully transistorized equipment have gained approval necessary for large-scale procurement. The item is a throw-away telephone repeater (ELECTRONICS, p 178, Jan. 1956).

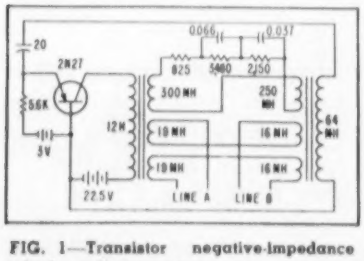


FIG. 1—Transistor negative-impedance telephone line repeater

The negative-impedance repeater (TA-287) is intended for use on field wire as a 2-wire intermediate, unattended type equipment. Designed for insertion at 6-mile intervals in a line, it can be employed in circuits using up to 30 miles of wet field wire with a net circuit loss of only 0.8 db per mile at a frequency of 1 kc.

In event of defective operation, the entire repeater is thrown away, since it is sealed in a waterproof compound with external wire leads, thus precluding repair.

Weighing about 3½ pounds, it will replace the EE-89 equipment, which weighs 16 pounds. It will likewise replace type TA-126 equipment in

BRANE Guides Bomber

Known less glamorously as the MA-2 bombing and navigation system, BRANE (*B*ombing *RA*dar *N*avigation *E*quipment) is the new name for equipment built by IBM for installation in the Boeing B-52 Stratofortress, the biggest, fastest bomber employed by Strategic Air Command. In the photograph, an Air Force officer peers into the bombsight periscope of the combined navigation-bombing device that weighs 1,457 pounds, requires 30 cubic feet of space and has over 300 electron tubes

KEPCO

Presents 2 New VOLTAGE REGULATED POWER SUPPLIES

KEPCO Voltage Regulated Power Supplies are conservatively rated. The regulation specified for each unit is available under all line and load conditions within the range of the instrument.

REGULATION: As shown in table for line fluctuations from 105-125 volts and load variations from minimum to maximum current.

SPECIAL FEATURE: Provision is made for picking up the error signal directly at the load, compensating for the voltage drop in external wiring.

Model 2600

OUTPUT	VOLTS	CURRENT	REGULATION	RIPPLE
1	0-60	0-2 Amp.	5 Mv.	1 Mv.

Model 2650

OUTPUT	VOLTS	CURRENT	REGULATION	RIPPLE
1	0-60	0-5 Amp.	5 Mv.	1 Mv.

30 MODELS AVAILABLE FROM STOCK. COMPLETE CATALOG ON REQUEST

WRITE DEPT.1

KEPCO LABORATORIES

131-38 SANFORD AVENUE • FLUSHING 55, N.Y. • INDEPENDENCE 1-7000

many applications. The latter unit weighs 65 pounds.

Other transistorized versions of communications equipment are under development at Signal Corps Engineering Labs. Among these are field telephones, 2 and 4-wire voice frequency repeaters, signal generators, telegraph line units, telephone ringers, teletypewriter tape sensing devices, audio test amplifiers, teletypewriter converters, dynamic microphone preamplifiers and other audio or intermediate-frequency devices.

Infrared Oil-Film Camera Shows Heat Patterns

Engineer adjusts the evaporograph (left) to pick up image of girl holding a glass of ice water. The picture (right) was taken in a completely darkened room at a distance of 30 feet

CALLED Eva (for Evaporograph) by Baird Associates, Inc., who developed it for the Signal Corps, a new instrument makes it possible to see many objects in the dark. A human body, automobile or other object that has differences in temperature can be seen easily and identified. A man can be spotted at 200 yards and a house a mile distant can be seen in total darkness.

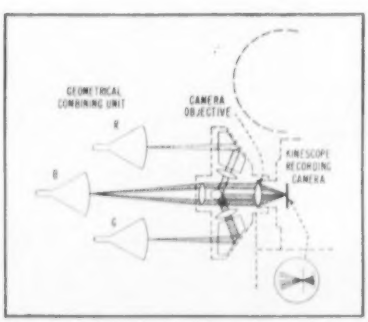
In operation, the evaporograph collects radiation emitted from an object and focuses it as an image upon an oil film. The oil evaporates from point to point at rates varying with the amount of radiation received at each point. Viewed in reflected light, the differences in oil-film thickness appear as different colors of the visible spectrum.

One practical use of the newly declassified device in the field of electronics may be photographing vacuum-tube envelopes or other components for studies of life expectancy. Temperature studies are now generally conducted by observing the effects of temperature at discrete points.

Lenticular Film For Color Kines

PRACTICAL help for the telecaster desirous of using color kinescope recordings may lie in the use of embossed film. Thus far, other methods, such as employment of magnetic tape, have not proved practicable.

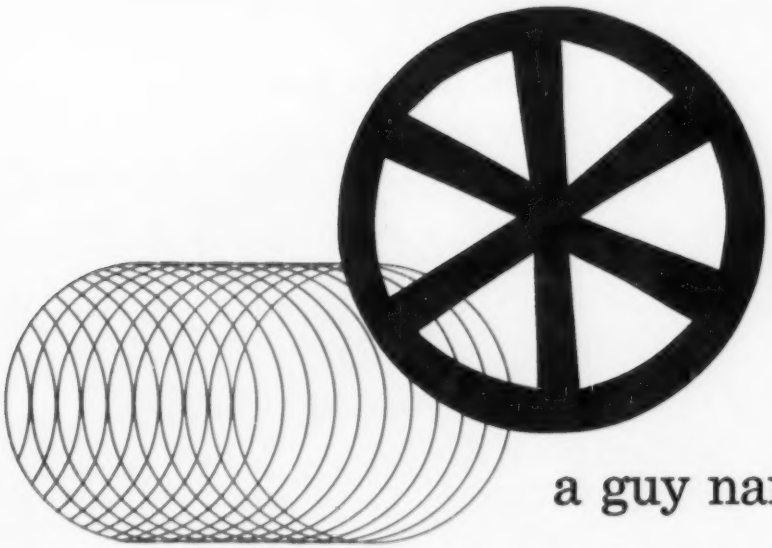
The diagram shows the principles of color kinescope recording on embossed film. The red, green and blue video signals in a color television system are fed to three separate kinescopes, marked respectively, *R*, *G* and *B*. The phosphor screens of the three kinescopes are all of the same type, for example, P-16.



Method of recording color programs on monochrome lenticular film

Tonal values of the red content of the scene being televised are represented by the tonal values of the picture appearing on tube *R*. This picture may therefore be referred to as a red-separation image. Similarly, the green separation appears on *G* and the blue separation on *B*.

► **Monochromes**—It should be noted that the pictures on the kinescopes are not themselves colored, red, green and blue. All pictures have the color that is characteristic of the phosphor used in all three tubes. For the P-16 phosphor, the light is blue, extending into the ultraviolet. By the design of the optical system, light



a guy named Og

Once your name was Og. You tired of shouldering mastodon steaks...of dragging your mate by her hair. You invented the wheel.

Later, your name was Watt. Steam made your kettle-lid dance...and the Industrial Revolution was on.

Yesterday, you were a bicycle mechanic named Henry...today, your brainchild's descendants are counted in millions.

Your name is legion. You created every linkage... every device...every system.

You're an engineer.

You make things work better...faster...more accurately ...more economically.

Next week...next month...next year...some system will need a better, faster, more accurate or more economical means of recording...or indicating...or computing...or controlling a process.

You'll want precision potentiometers.

You'll discover that Helipot makes the most complete line... linear and non-linear versions...in the widest choice of sizes, mounting styles and resistances.

many models of HELIPOT* *precision potentiometers are stocked for immediate shipment ...our engineers will gladly adapt standard* HELIPOTS *to your requirements...or build entirely new* HELIPOTS *for you.*

for information and specifications ...write for data file 401

You're an engineer. Your career is in the making. Helipot would like to hear from you.

Helipot *first in precision potentiometers*

Helipot Corporation/South Pasadena, California
Engineering representatives in principal cities
a division of BECKMAN INSTRUMENTS, INC.

from *R* reaching the kinescope recording camera film appears to come from one of four parallel apertures, or bands.

Light from *G* comes through a second one of these apertures and light from *B* comes through the remaining two apertures. In the diagram, which schematically displays a vertical cross-section of the optical system, the four bands of light approach the camera objective lens from the left.

An enlarged view of a cross-section through the recording beams and embossed film is shown in the circle at the bottom right of the diagram. The film has tiny cylindrical lenses called lenticules, formed in the film base itself by an embossing process.

These lenticules face the camera lens, so that light entering the camera must pass through the lenticules before striking the light-sensitive emulsion that is coated on the back of the support. The camera lens forms images of all three kinescope rasters, superimposed in register on a single frame of the film. Simultaneously, each lenticule images the four separate apertures on the emulsion lying directly behind itself. Thus the red, green and blue separation images are recorded in separate positions within the emulsion.

▶ **Lens Ridges** — Each lenticule runs transversely all the way across the 35-millimeter film width and there are 25 lenticules per millimeter of film length. The recorded image of the televised object is thus divided into about 390 horizontal strips, corresponding to the number of lenticules contained in the height of a 35-millimeter motion-picture frame. Each of these strips is further divided into red, green and blue components.

It is an important fact that the emulsion layer is an ordinary blue-sensitive black-and-white type. The color separations are obtained as colorless, silver images. Since complicated color processing of the film is not required, it can be developed rapidly, easily meeting the requirements for time-zone-delayed broadcasting.

Televising embossed film color records is accomplished either by means of a flying-spot scanner, which requires the use of a continuous projector, or by means of storage tubes such as the Vidicon, in which case an intermittent projector is used.

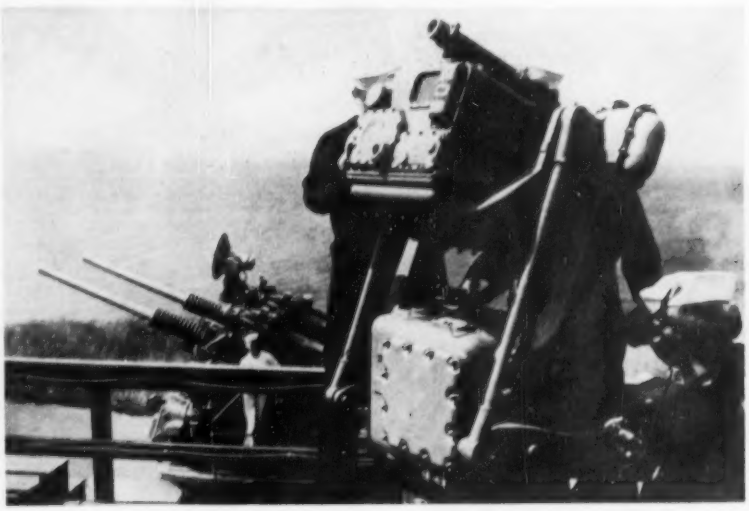
A suitable optical system for use with Vidicons is essentially the reverse of the geometrical combining unit used in recording. In this case, the film as it passes through the projector gate is illuminated from the emulsion side. Light transmitted by the various black-and-white color-separation images in the film is directed by the film lenticules in bands corresponding to the taking apertures.

Suitably arranged reflecting surfaces and lenses image the three separations on three different Vidicon storage surfaces, serving the red, green and blue channels of the television system.

In addition to meeting the time requirements for quick-kine recording, embossed film gives high-quality color rendition and picture sharpness. Furthermore, a permanent record is obtained from which color prints may be made on ordinary color films.

The greater part of this report has been kindly furnished by the Research Laboratories of Eastman Kodak Co.—A. A. McK.

Gunfire Control Tracks Jets



Tracking jet aircraft with 3 and 5-inch naval guns in any weather is possible using U. S. Navy's mark 63 gunfire control system manufactured by Sperry Gyroscope Co. Newer gunfire controls and radars have been combined with gyro-optical tracking principles used previously

WWV Modifies Broadcasts

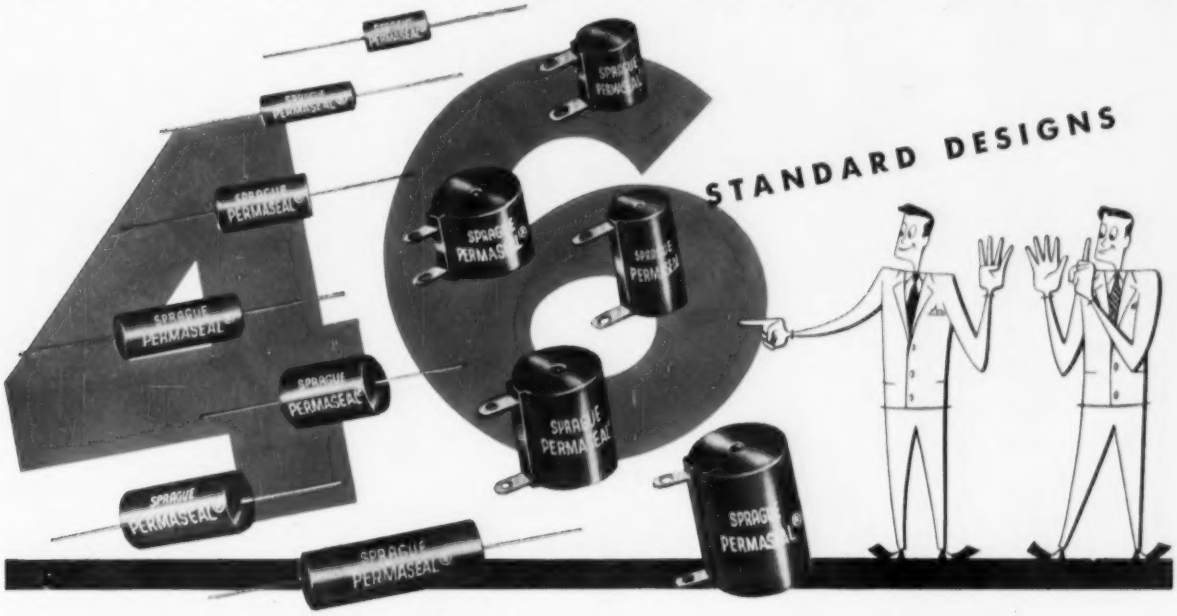
TIME signals from WWV, near Washington, D. C., are maintained in close agreement with a new uniform time called UT2, determined by the U. S. Naval Observatory. Occasional step adjustments of exactly plus or minus 20 milliseconds are made on Wednesdays at 1900 UT (Universal Time, which corresponds with GMT).

The time adjustments are necessary several times a year because of variations in the earth's rate of rotation. Final corrections to the broadcast time signals are published weekly by the Naval Observatory.

▶ **Frequency**—Improvements have been made in the accuracy of broadcast frequencies, which are now accurate to a part in 100 million. Carrier frequencies of 2.5, 5, 10, 15, 20 and 25 mc are used, the frequencies of 30 and 35 mc having been discontinued Jan. 1, 1953.

To give longer intervals free from modulation, the tones 440 and 600 cps have recently been shortened from 4 to 3 minutes duration. This is likewise true for WWVH near Maui, Hawaii. A silent period of 4 minutes is observed by WWV commencing at 45

A COMPLETE LINE OF DEPENDABLE ENCAPSULATED RESISTORS



PERMASEAL®

PRECISION WIREWOUND RESISTORS FOR 85C AND 125C AMBIENTS

For applications requiring accurate resistance values at 85C and 125C operating temperatures—in units of truly small physical size—select the precise resistor you want from one of the 46 standard Permaseal designs in tab or axial lead styles.

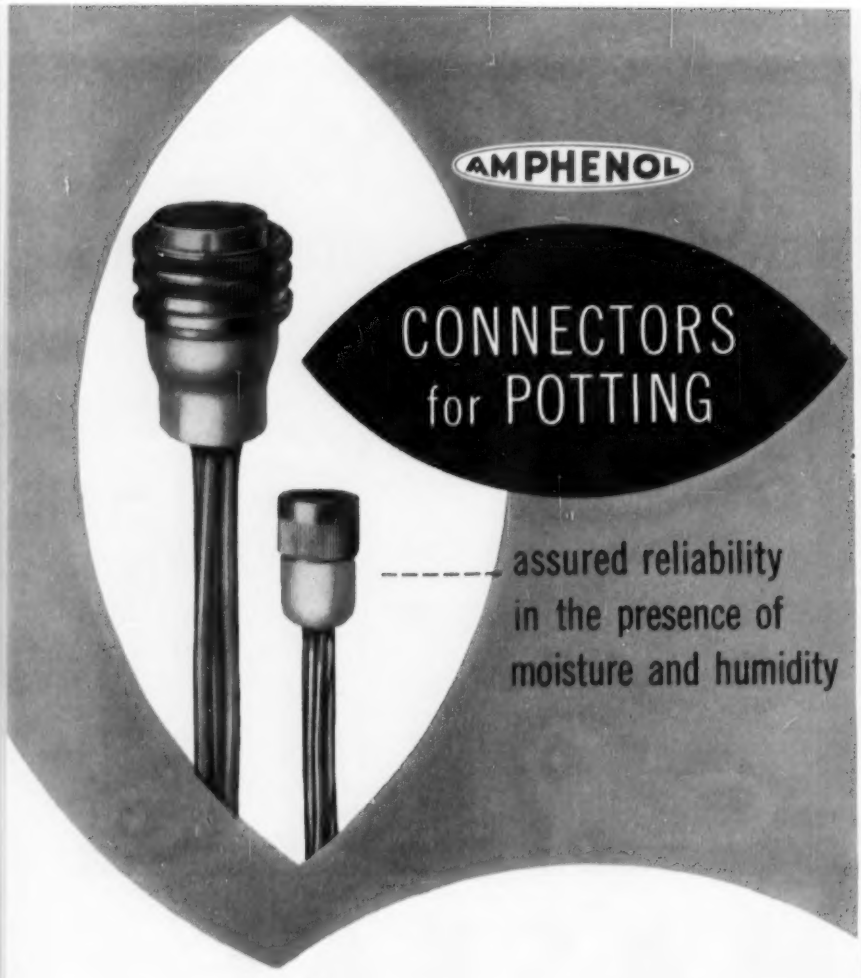
Winding forms, resistance wire and embedding material are matched and integrated, resulting in long term stability at rated wattage over the operating temperature range. The embedding material is a special plastic that extends protection well beyond the severe humidity resistance specifications of MIL-R-93A and Proposed MIL-R-9444 (USAF).

These high-accuracy units are available in close resistance tolerances down to ± 0.1%. They are carefully and properly aged by a special Sprague process so that they maintain their accuracy within the limits set by the most stringent military specifications.

SPRAGUE

FOR COMPLETE DATA WRITE FOR COPY OF SPRAGUE ENGINEERING BULLETIN NO. 122A

SPRAGUE ELECTRIC COMPANY • 35 MARSHALL ST. • NORTH ADAMS, MASS.



Potting of electrical connectors was pioneered by AMPHENOL in 1953—today a complete selection of AN and Miniature AN-type connectors are available from AMPHENOL in potting constructions.

The greatest benefit from potting is assured electrical reliability in the presence of moisture and humidity. Potted assemblies provide complete protection against the effects of moisture, fuel, oil, lubricants, hydraulic fluid, salt spray and carbon tetrachloride. Potting offers an actual bonded seal—not a seal dependent upon critical face-to-face mechanical seals which tend to create moisture traps under temperature cycling. The potted assembly is tamper-proof and vibration resistant. Potting provides cost, weight and space reduction.

For complete information (background, methods, ordering) send for the newly issued brochure:
AMPHENOL CONNECTORS FOR POTTING

AMERICAN PHENOLIC CORPORATION
chicago 50, illinois
AMPHENOL CANADA LIMITED *toronto 9, ontario*

minutes, plus or minus 15 seconds, after each hour.

▶ **Single-Sideband**—Except on 25 mc, the tone frequencies of 440 and 600 cps from WWV are being operated experimentally as single upper sideband with full carrier. Power output from the ssb transmitter is about a third the carrier power. Announcements and seconds pulses use double-sideband 100-percent amplitude modulation.

Many other technical details can be obtained by writing National Bureau of Standards, Boulder Laboratories, Boulder, Colorado.

Low Capacitance Probe For Video Testing

By HOWARD L. ROBERTS
Denver Research Institute
University of Denver
Denver, Colorado

IN SIGNAL TRACING pulse and video circuits, the input capacitance of the usual oscilloscope probe is generally sufficiently large (12 to 15 $\mu\mu$f) to load the circuit under test. In addition, capacitance added by a probe may disturb the time constant of R-C circuits.

The need for a low input capacitance oscilloscope probe that does not overly attenuate the signal gave rise to the instrument to be described in this article. The instrument consists of a tandem cathode-follower that has an input capacitance of less than 3 $\mu\mu$f and an attenuation of only 2-to-1.

Input capacitance of a triode-connected cathode-follower is

$$C_{IN} \approx C_{gp} + (1 - G)\, C_{gk}$$

where C_{gp} is the grid-plate capacitance, C_{gk} is the grid-cathode capacitance of the triode and G is the gain of the cathode-follower.

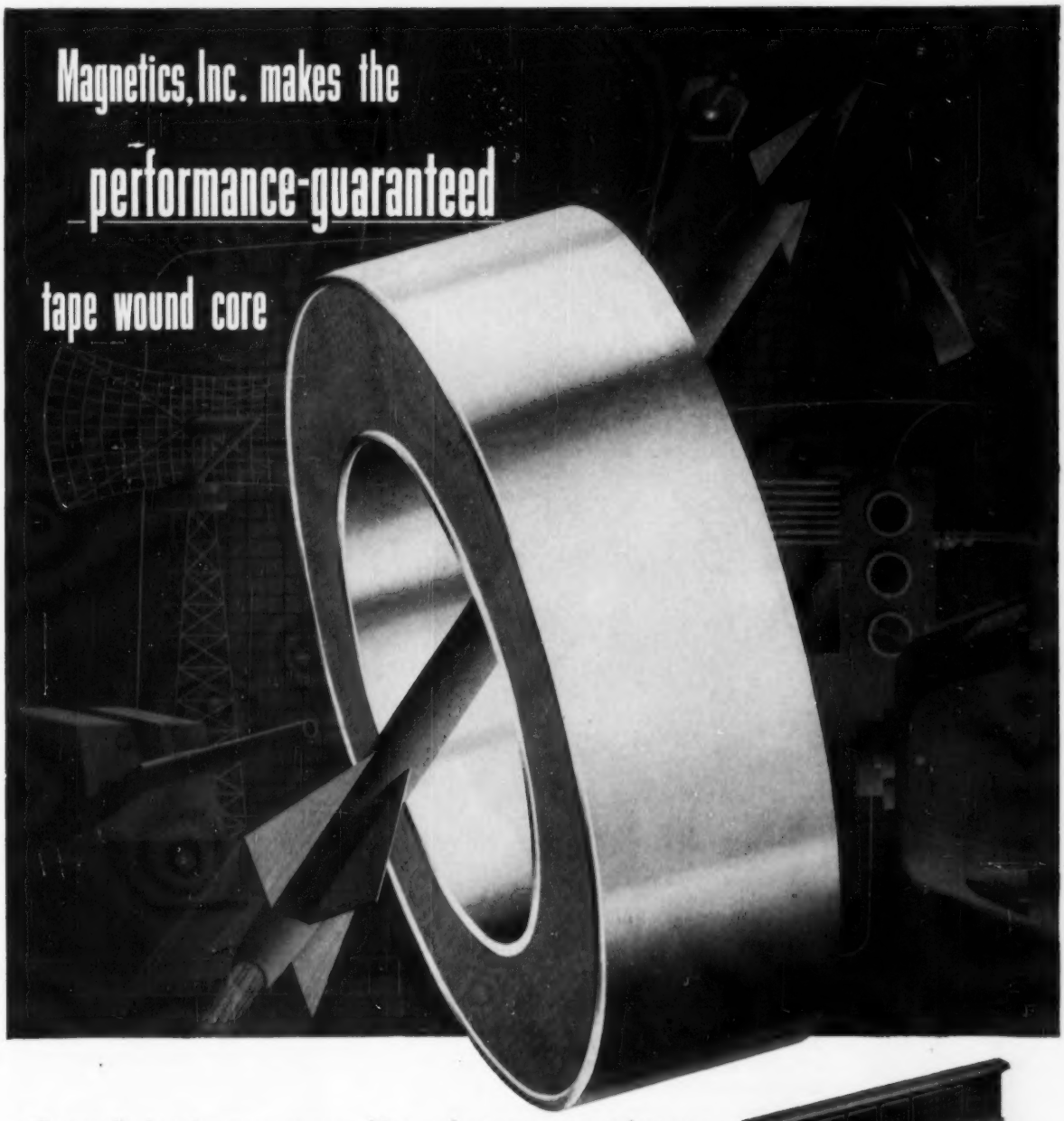
The grid-plate capacitance can be practically eliminated by the use of a pentode with the suppressor tied to the cathode and the screen bypassed to the cathode. In this case, the input capacitance is

$$C_{IN} \approx (1 - G)\, (C_{gk} + C_{gs})$$

where C_{gs} is the grid-screen capacitance of the pentode.

Total input capacitance for a given tube, disregarding wiring capacitance, now depends upon the

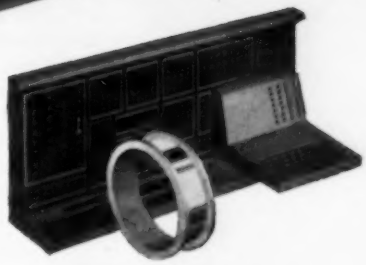
Magnetics, Inc. makes the performance-guaranteed tape wound core



Core quality is no longer your worry—it's ours, for we guarantee performance of our tape wound and bobbin cores to mutually agreed upon specifications. What's more, you can specify a host of extra Magnetics, Inc. exclusive features. These include the Aluminum Core Box*, to withstand the rigors of temperatures to at least 450°F., vacuum impregnation, heavy winding stresses and vibration—and the color-coded bobbin core, for error-free handling in storage and assembly.

Why not write today for your copy of Catalog TWC 100-A? And if you have an application problem, our sales engineers are ready to provide you with expert assistance. *Magnetics, Inc., Dept. E-29, Butler, Pennsylvania.*

*Patent Pending



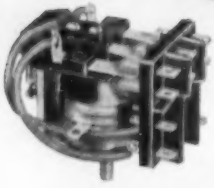
Magnetics' bobbin cores, too, are performance-guaranteed!

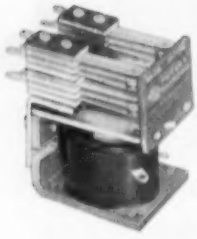
MAGNETICS inc.

CABLE: Magnetics

LOW COST—HIGH QUALITY

Relays-a-Plenty





Potter & Brumfield, with its many years of Engineering and Production experience, builds relays to all quality levels.

Relays from the most exacting to the simplest in operating specifications are readily available at P&B.

Small or Large quantity orders receive the same careful attention by the people that have the "Know How."

Let Potter and Brumfield engineers become part of your design group in selecting the correct type of relay to meet all requirements.

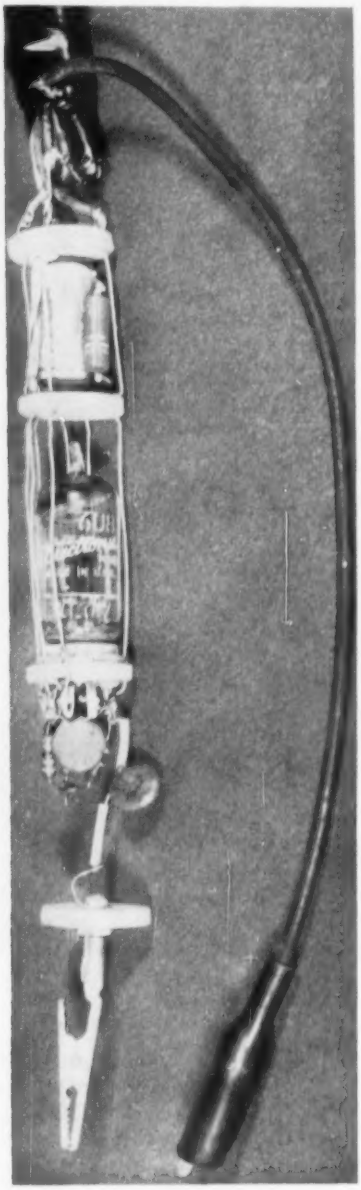
For quick delivery over 350 different standard relays stocked by 500 Franchised Electronic Parts Distributors throughout the United States and Canada.

Send your specifications for samples and quotations.

Potter & Brumfield
PRINCETON, INDIANA inc.
SUBSIDIARY OF AMERICAN MACHINE AND FOUNDRY COMPANY

gain of the cathode-follower—the higher the gain, the lower the capacitance.

Physically, this means that the



Components mounted on tube socket are connected to power supply and output wiring by bus wires running up sides of tube as shown in the photograph

more nearly the cathode and screen voltage follow the grid voltage, the less capacitive effect there will be between the grid and these elements. Thus it is desirable to make the gain of the cathode-follower as near unity as possible

New 350

A SUPERIOR LOW-FREQUENCY INSTRUMENT BY

DU MONT

The Type 350 combines the best features of all previously available low-frequency instruments. It is an entirely new low-frequency instrument that *must* be seen to be appreciated

Identical X- and Y- amplifiers permit accurate measurements up to 150 KC. Identical phase response between the two amplifiers allows accurate phase-shift measurements of minute phase differences. Internal calibration is provided for both amplifiers.

Stability-wise, the Type 350 has no peer. Regulation of all circuits, including the filaments, permits accurate measurements over many hours. The illuminated, calibrated scale assists in measurements. High accelerating potential permits operation with long-persistence screens.

Modern hard-tube sweep circuit provides superior linearity with beam gate for forward trace brightening. This sweep circuitry eliminates practically all time distortion over the range of sweeps from ½ sec/inch to 2 usec/inch.

These and many other new features make the Du Mont Type 350 the standard of performance in low-frequency oscillography.
Write for complete technical details...

Price $395

DU MONT

TECHNICAL SALES DEPARTMENT
ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J.

Announcing... **MEASUREMENTS'**

MODEL 95

STANDARD SIGNAL GENERATOR

Frequency Modulated

- *Broad Frequency Coverage*
- *Extended Modulation Range*
- *Wide FM Deviation*
- *Low Distortion*

MEASUREMENTS' Model 95 Standard Signal Generator is designed and engineered to meet the rigid test requirements imposed on modern high quality electronic instruments. It provides frequency coverage between 50 Mc and 400 Mc. Frequency modulation is continuously variable, and the degree of deviation is directly shown in kilocycles on a panel meter. The Model 95 with its extremely high stability and low distortion makes this instrument indispensable for critical measurements on FM receivers, multiplex and telemetering equipment.

The Model 95 with its low residual fm, less than 60 DB below full deviation, permits accurate evaluation of equipment characteristics in which low noise level is essential. An internal barretter bridge in conjunction with mutual inductance type attentuators provides a high degree of output voltage accuracy.

The Model 95 Standard Signal Generator is now available from production.

SPECIFICATIONS

CARRIER FREQUENCY RANGE: 50 to 400 Megacycles in 3 bands, 50-100 Mc. 100-200 Mc. 200-400 Mc.

FREQUENCY ACCURACY: ± 1% Direct reading dial.

FREQUENCY DRIFT: Less than .05% after warm-up.

OUTPUT VOLTAGE: Continuously variable from 0.1 to 100,000 microvolts.

OUTPUT VOLTAGE ACCURACY: At 100,000 microvolts the output voltage accuracy is ± 10%.

OUTPUT IMPEDANCE: 50 ohms, VSWR less than 1.4

LEAKAGE AND STRAY FIELDS: Attenuator leakage less than 0.1 microvolt. Power line leakage and stray fields negligible.

MODULATION: Frequency modulation continuously variable,
0-150 Kc on 50-100 Mc band,
0-300 Kc on 100-200 Mc band,
0-600 Kc on 200-400 Mc band.

MODULATION FREQUENCY: Internal 400~ and 1000~, ± 5% accuracy. External modulation flat within ± 1 db, 250~ to 70 Kc.

FM DISTORTION: Less than 0.5% for 75 Kc deviation on 50-100 Mc band, 150 Kc deviation on 100-200 Mc band, 300 Kc on 200-400 Mc band.

RESIDUAL FM: Better than 60 db below full deviation.

POWER SUPPLY: 117 volts 50-60 cycles, 140 watts.

DIMENSIONS: 17-1/4" wide x 11-3/16" high x 14-7/8" deep overall.

WEIGHT: Approximately 70 pounds.

Laboratory Standards **MEASUREMENTS CORPORATION**
BOONTON · NEW JERSEY

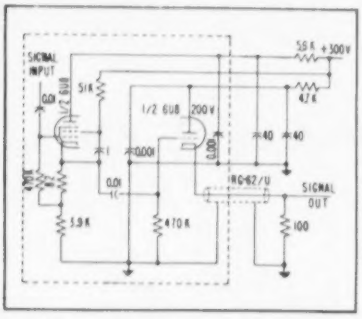
to reduce the input capacitance.

Gain of a cathode-follower

$$G \simeq \frac{g_m R}{1 + g_m R}$$

where R is the cathode load resistor.

From this, it is seen that it would be desirable to make R large to cause the gain to be as near unity as possible. However, this is contrary to the requirement that the cathode-follower drive a low-impedance cable. This difficulty is surmounted by using an input cathode-follower with high gain to drive another cathode-follower providing the proper output impedance.

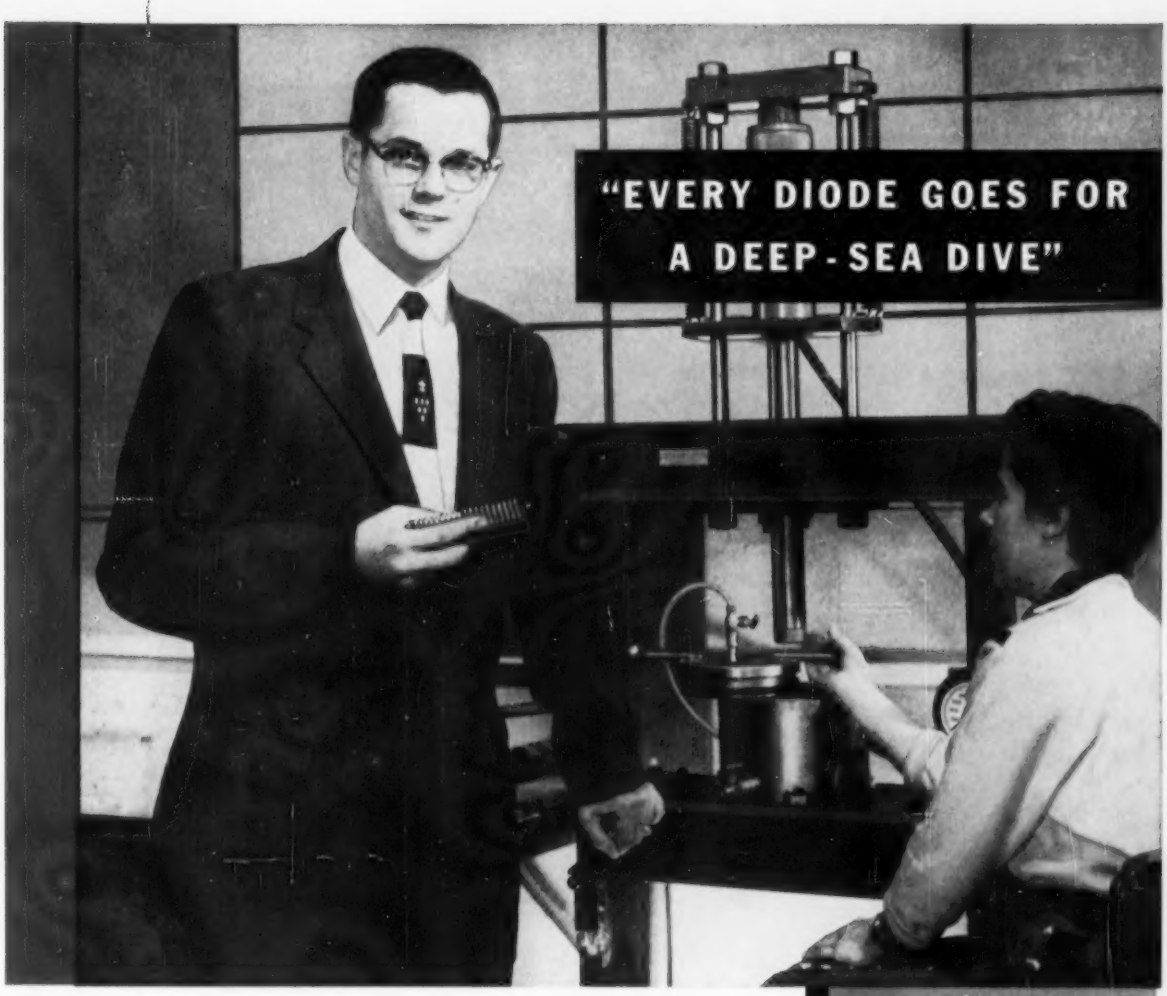


Tandem cathode-follower probe has attenuation of only 2 to 1 with input capacitance of less than 3 $\mu\mu$f

A 6U8 triode-pentode was used with the pentode section as the input. In choosing a cathode resistor for the input stage, transient response of the circuit had to be considered. Gain considerations dictate the use of a large load resistor but the R-C time constant of the cathode circuit should be as low as possible for good transient reponse.

A compromise was reached by choosing a cathode resistor no larger than necessary for maximum gain. The calculated gain for the 6U8 pentode section with a cathode load resistor of 3,900 ohms is 0.95, assuming a transconductance of 5,000 μmhos at the particular operating point chosen. If the normal input capacitance for the tube is considered as 5 $\mu\mu$f, the calculated input capacitance for the cathode-follower circuit is 0.25 $\mu\mu$f.

The input resistance of the circuit is higher than the 470,000-ohm grid resistor shown on the circuit diagram. When the grid resistor is returned to the cathode network, to establish correct grid-



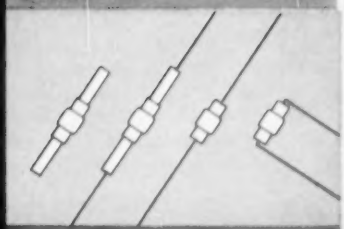
Morgan McMahon, Head of Engineering Services, is in charge of PSI's product applications and manufacturing engineering. Here he holds diodes prior to subjecting them to 1000 p.s.i. hermetic seal test.

"In effect, we take each PSI Diode on a deep-sea dive during our hermetic seal test. *Every* unit is immersed in liquid inside a pressure bomb and subjected to 1000 p.s.i. pressure. Then we test it, viewing its dynamic characteristics on an oscilloscope. Any unit exhibiting instability or possible long-term degradation (evidenced by hysteresis, drift, flutter, discontinuities, excessive reverse current, or low breakdown voltage) is rejected.

"Since no diode is actually *used* under 1000 p.s.i. pressure, what's the point? Just this: Only through application of very high liquid pressures is it possible to identify minute openings through which moisture or other damaging contaminants can ultimately migrate during the service life of the diode. This rigid test increases assurance of the long term reliability of PSI diodes, and therefore, the reliability of the equipment in which they are used."

COMPARE IT YOURSELF!

If you wish to compare your own procedures for evaluating semiconductor hermetic seals to the Pacific Semiconductors' 1000 p.s.i. liquid-pressure test described here, we will be pleased to send complete test instructions and an equipment list upon request.



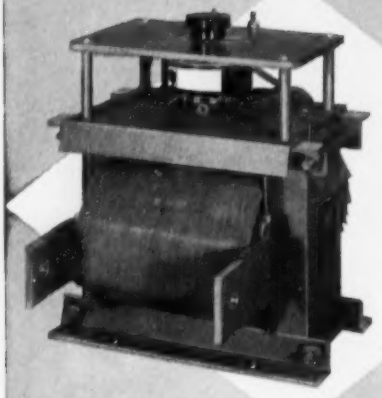
PSI germanium and silicon diodes (here, actual size) are offered with these four basic lead arrangements.

PACIFIC SEMICONDUCTORS, INC.
10451 WEST JEFFERSON BOULEVARD
CULVER CITY, CALIFORNIA

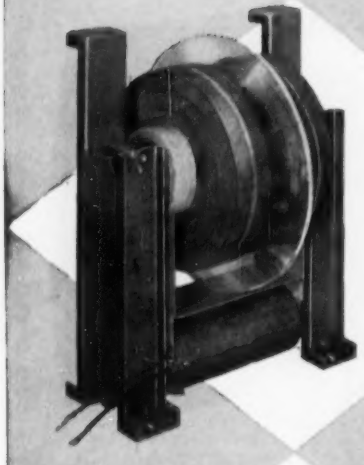
Want more information? Use post card on last page.

TRANSFORMERS for your SPECIAL REQUIREMENTS

TWO NEW NWL SPECIAL UNITS



Resistance Welding Transformer with eight point tap-changing switch on primary winding. Used for a varying secondary current output. Unit shown is 3 KVA. Units are available from .5 to 50 KVA.



High Voltage Plate Transformer for use under oil with other equipment in same tank. Unit shown is 50 KV center tap grounded, 4 KVA and high impedance. Note plastic insulation shield between coils. This unit available from 100 VA to 100 KVA.

For any special transformer, you will get the highest quality, the fastest delivery, the most reasonable cost and the highest efficiency from Nothelfer Winding Laboratories. Their production is geared to the manufacture of special transformers, chokes and reactors.

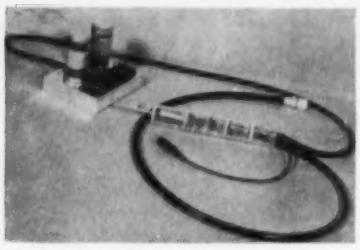
Write for complete information, specifying your particular requirements.

NWL Nothelfer WINDING LABORATORIES, Inc.

P. O. Box 455, Dept. 102, Trenton, N. J.

cathode bias, the input resistance is $R_s \left[\frac{e_1}{e_1 - e_2}\right]$ Here, e_2 is equal to $0.95e_1$ so that the input resistance is calculated to be 9.4 megohms.

The pentode section is capacitively coupled to the triode section which serves as the output cathode-follower driving the low-impedance cable. The cathode resistor for the triode serves also as the terminating resistor for the cable and its size is therefore determined by the characteristics of the cable. An RG-62/U cable terminated with 100 ohms was found satisfactory if the input signal did not exceed 2 volts peak-to-peak, as the circuit overloaded for signals larger than 2 volts.



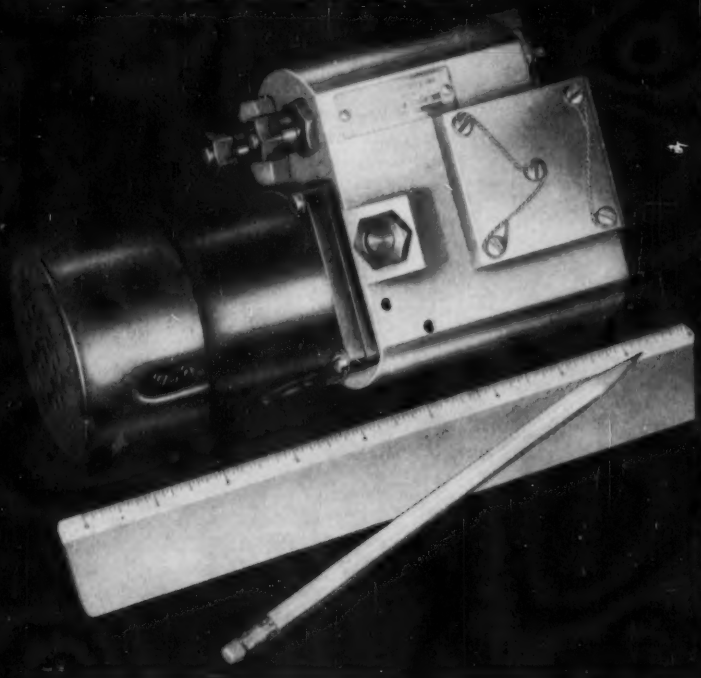
Video probe with power-supply filter chassis. Cable terminating resistor is located in cable connector

Since the particular application for this probe required that the probe be able to accept input signals as large as 8 volts peak-to-peak, the maximum output of the driver stage was increased by using a 200-ohm load and RG-114/U cable.

Mechanical design required that the probe be of convenient size, and that the input network have minimum wiring capacitance and be adequately shielded. The photograph shows the layout of the parts within the probe. The components that carry the a-c signal are grouped together on the bottom side of the tube socket, except for the relatively large screen by-pass capacitor which is located in the space above the tube.

The other leads from the tube socket are brought around the tube by the bus-wires shown. There is enough space between one pair of the bus-wires to permit replacement of the 6U8. The d-c filter components are located with the

AIRCRAFT-TYPE
hydraulic
POWER UNITS . . .



To supply dependable hydraulic power for critical applications, Eastern units are engineered to perform under extreme conditions. Compact design and varying motor sizes make them unique power sources, especially desirable for airborne use. The equipment illustrated in detail presents a typical Eastern Power Unit designed for one application. Many other requirements can be satisfied with designs of this general type.

Unit consists of: positive-displacement pump, electric motor drive, oil reservoir, expansion chamber, porous bronze ten-micron filter, pressure regulating valve, filter relief valve, and expansion relief valve.

SPECIAL UNITS to be built into Servo Systems and specialized projects are available. As illustrated below, Actuators combined Servo-valve and Actuator, and Servo-valve Hydraulic System combinations are being produced by Eastern for custom-specified jobs. If your project involves equipment of this type, write to us for further information.

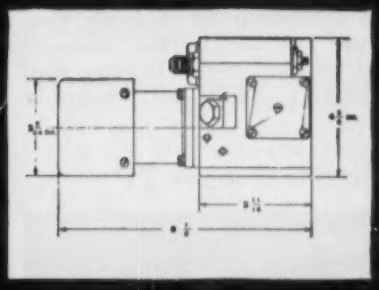
Specifications:

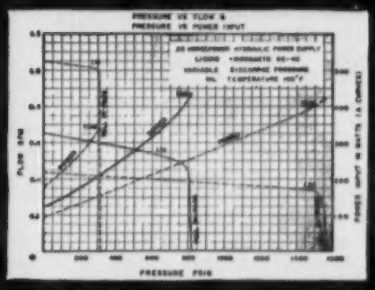
Available with either 1/8, 1/4, or 1/2 horsepower motor, in 28 V. D.C. or 400 Cycles 3 Phase power.

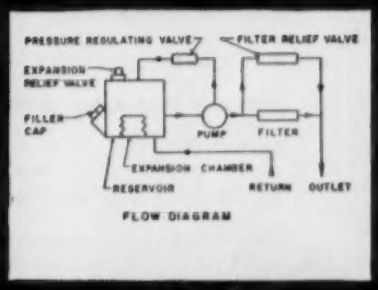
Available with various pump characteristics. Under certain operating conditions, units can be made self-cooling. *Example*: 1/4 H.P. Unit has a continuous-duty oil-temperature rise above ambient of approximately 60° F. at sea level.

Pressure range from 0 to 1500 PSIG with compatible flow.

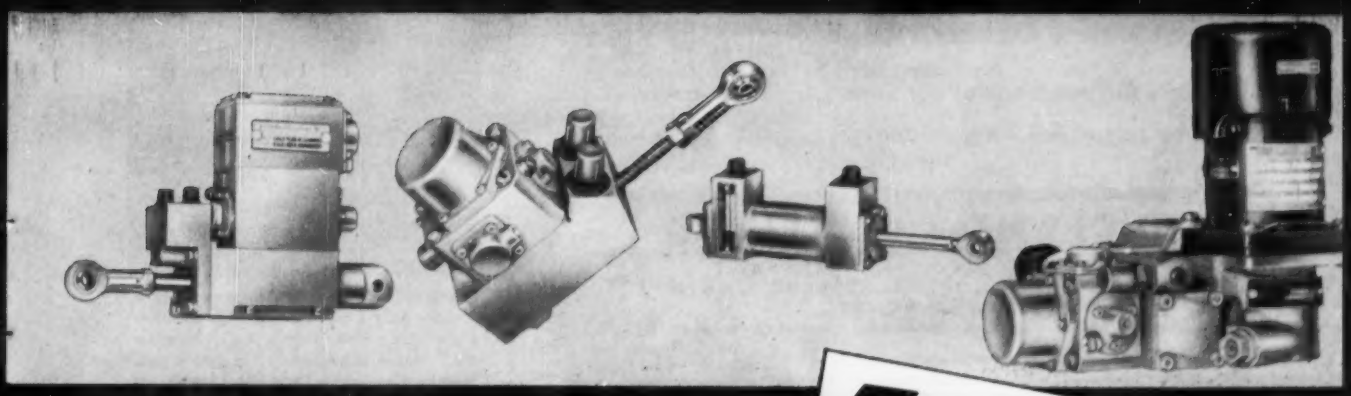
Anodized aluminum body contains all components except motor.





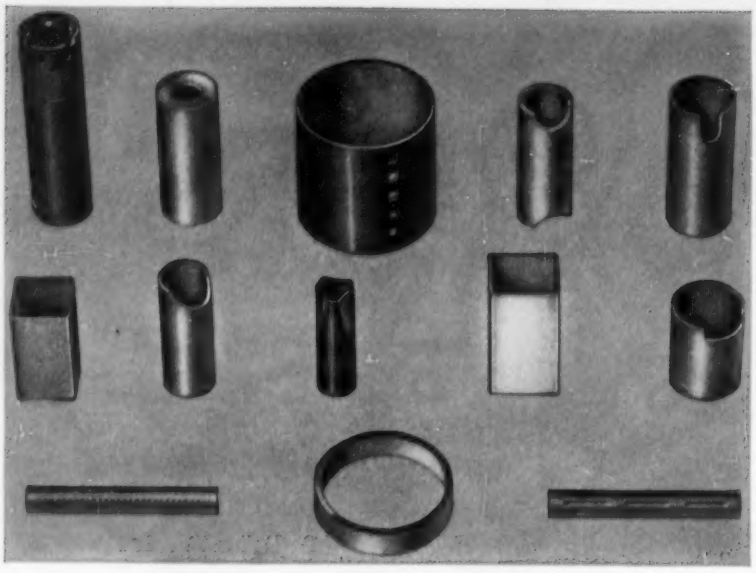


FLOW DIAGRAM



☆ *Write for Aviation Products Catalog 340*

Eastern
INDUSTRIES, INC.
100 SKIFF STREET
HAMDEN 14, CONN.



CLEVELITE *

THE PHENOLIC TUBING OF QUALITY

Low moisture absorption . . . Dimensional stability . . . High dielectric strength . . . Low loss . . . Great physical strength . . . Good machinability.

This combination of Clevelite's "Built-in-Quality" provides that extra protection for better product performance.

Minimize rejects and inspection costs . . . for Quality of material and workmanship . . . Specify Clevelite . . . The economical tubing!

FAST DEPENDABLE SERVICE

Write for your copy of our latest CLEVELITE brochure!

Why pay more? For good quality . . . call CLEVELAND!

*Reg. U. S. Pat. Off.

THE
CLEVELAND CONTAINER COMPANY
6201 BARBERTON AVE. CLEVELAND 2, OHIO
PLANTS AND SALES OFFICES:
CHICAGO • DETROIT • MEMPHIS • PLYMOUTH, WIS. • OGDENSBURG, N.Y. • KINGSBURG, N.J. • LOS ANGELES
ABRASIVE DIVISION at CLEVELAND, OHIO
Cleveland Container Canada, Ltd., Prescott and Toronto, Ont.

Representatives:
NEW YORK AREA: R. T. MURRAY, 604 CENTRAL AVE., EAST ORANGE, N. J.
NEW ENGLAND: R. S. PETTIGREW & CO., 62 LA SALLE RD., WEST HARTFORD, CONN.
CHICAGO AREA: PLASTIC TUBING SALES, 5215 N. RAVENSWOOD AVE., CHICAGO
WEST COAST: IRV. M. COCHRANE CO., 408 S. ALVARADO ST., LOS ANGELES

power supply and the d-c voltages are brought to the probe, along with the filament current, on a separate cable.

The input is shielded by a copper cylinder that fits inside the probe wall and around the a-c circuit components. Another thin sheet of plastic on the inside surface of the copper shield insulates it from the components within.

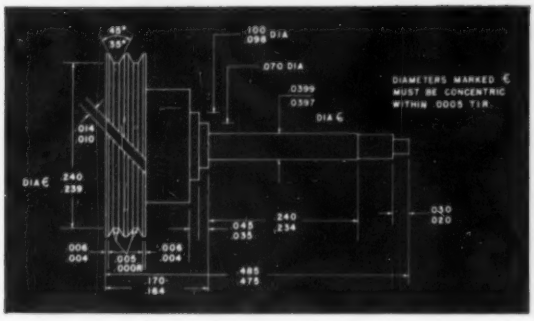
The shield is electrically attached to the output circuit and therefore moves voltagewise with the components within it, minimizing capacitance between these elements and the shield. The low-impedance source to which the shield is attached reduces electrical pick-up from extraneous sources.

The probe body itself is a plastic cylinder that has a relatively high melting point. Ventilation holes aid in dissipating the heat generated within the 6U8.

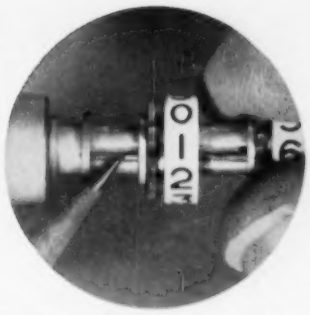
The equipment available for testing the bandwidth of the probe indicated that its frequency response was flat to at least 10 mc. Satisfactory transient response was demonstrated by inserting the probe in series with the video line of a closed-circuit tv system that was reproducing the standard RETMA test pattern to better than 600 lines. Except for the loss in

Reconnaissance TV

The hand-held television camera shown weighs only 8 pounds. Transmitter, complete with power supply that will transmit pictures continuously for two hours, weighs 47 pounds. Developed by Signal Corps Engineering Laboratories, the new equipment has a range of about a mile. It could be set up to report, unmanned, from a radioactive or other hazardous location



Inspection of incoming precision shafts took 10 to 15 minutes each by mechanical gaging—involved concentricity, diameters, shoulder locations, and other tough-to-measure dimensions to tolerances of .0002". Doing the work on a Kodak Contour Projector cut time to 2 to 3 minutes per shaft.



The problem was to check many small calculating machine parts averaging about 13 critical dimensions for each with shapes mostly complex. With carefully engineered mechanical gages, inspection time averaged 50 seconds each. Optical gaging on a Kodak Contour Projector brought the average down to 12 seconds.

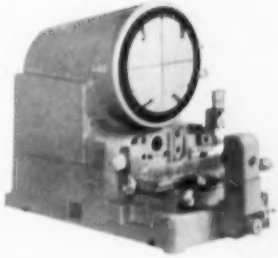
Spacing the parallelism of a special tuning condenser for electronic test equipment had to be held to very close tolerances. "Use of the Kodak Contour Projector," the company reports, "permits economical measurements of parallelism to an accuracy impossible to obtain by other methods."

On a flexible rubber-like part, rejects ran as high as 30%. By using a Kodak Contour Projector to measure the parts and then plotting results by statistical quality control methods, production changes were made that resulted in rejects dropping from 30% to less than ¼ of 1%. Optical gaging eliminated distortion of the part while gaging, and proved 4 to 5 times faster than usual methods.

One instrument inspects these varied parts

Here is another economy optical gaging can provide: switching from one part to a second part requires only a change of chart and fixture. You still use the same basic instrument. And with a Kodak Contour Projector, the variety of parts you can check is almost without limit. Here's why:

1. *Capacity*—Screen size on an optical comparator does not restrict the size of parts you can handle, for multiple-position fixtures allow the handling of parts larger than the screen itself. What's important is the staging area—and Kodak's unique relay lens provides uniform ample clearance regardless of magnification. The distortion-free image lets you measure anywhere on the viewing screen. The choice of lenses, of horizontal or vertical projection, and of surface or shadow illumination gives you the greatest possible flexibility.
2. *Ease of operation*—Kodak Contour Projectors are designed for maximum speed and minimum operator training. The bright screen image reduces fatigue, lets you use the instrument in normal room light. Images are erect and unreversed at all magnifications. Finger-tip controls are within convenient reach of the operator.
3. *Optical stability*—The adjustment-free optical elements on Kodak Contour Projectors eliminate the need for operator adjustments. Rigidly mounted lenses and mirrors maintain alignment and position. Rugged construction withstands rough and heavy use.



Whether you are now using optical gaging or just considering it, you should have a copy of the booklet, "Optical Gaging with Kodak Contour Projectors." It gives complete details on Kodak optical gaging equipment and how it can work for you. Write to *Special Products Sales Division.*

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Kodak
TRADE MARK

OUT OF THIS DUST-FREE CONTROLLED ATMOSPHERE ASSEMBLY ROOM . . .

A big advance in hi-precision 10-turn potentiometers

Quality Far Beyond Anything of Comparable Price

Standard Linearity ± .3% (as close as ± .025% available)
Standard Resistance Tolerance ± 3%
Standard Resistance Range 500Ω to 400KΩ
(Resistance Tolerance as close as ± .5% available)

SPECTROL
Hi-Precision Model 800
priced far below anything of comparable quality
$12.00 in lots of 1 to 25.
Quantity discounts above 25 units.

Cost advantages are not made by shortcuts at Spectrol. Design and production knowhow make the cost savings. Every potentiometer is produced under the same hi-standard conditions—from precision winding to the rigid quality-controlled final assembly.

That's why the 10-turn Model 800 provides accuracy which out-classes others at comparable cost—and in addition to closer electrical tolerances—offers other quality features like machined aluminum lids, precision-ground shafts, and dimensionally stable laminated phenolic housings.

Versatile, accurate, reliable over a long life—available in volume quantities—immediate delivery from stock—the Model 800 is a great advance.

Write or call for more details about the wide variety of special features available—and about Spectrol's miniature and single turn potentiometers—today.

Write for catalog or contact your nearby Spectrol representative—

SPECTROL **Electronics Division of Carrier Corporation**
1704 South Del Mar Avenue, San Gabriel, California

ALBUQUERQUE, N.M. Gerald B. Miller Co.
BELMONT, CALIF. Gerald B. Miller Co.
BOSTON Gerber Sales Co.
CHICAGO Knoblock & Malone
DAYTON Robt. B. Burtner Co.
DETROIT Electro-Mec Associates
FT. WORTH Thomson Eng. Service
HOLLYWOOD Gerald B. Miller Co.
MINNEAPOLIS Fred B. Hill Co.
NEW YORK D. R. Bittan Co.
PHILADELPHIA Samuel K. MacDonald, Inc.
PITTSBURGH Samuel K. MacDonald, Inc.
SAN DIEGO Gerald B. Miller Co.
SEATTLE, WASH. Seatronics
ST. LOUIS Thomson Eng. Service
SYRACUSE Wally B. Swank
WASHINGTON, D.C. Samuel K. MacDonald, Inc.

gain (0.5), there was no loss in quality of the test pattern while the probe was in the line.

While the same pattern was being reproduced on the tv system, the probe was then attached to various points in the video amplifier circuits without disturbing the quality of the test pattern reproduction, thereby demonstrating that the capacitance introduced by the probe was sufficiently small to prevent loading of the video circuits.

Tube Interchangeability

OF INTEREST to industrial electron tube users is a revised edition of a commercial publication listing 2,000 type designations of 26 different manufacturers. Vacuum power tubes, rectifiers, magnetrons, phototubes and oscillograph types are among categories covered in the industrial listing. The manual is available at moderate cost from RCA Tube Division, Harrison, N. J.

Hurricane Prediction

SEA WATER, an electrical conductor moving through the earth's magnetic field, generates an electromotive force. Across the Florida Straits, from Key West to Havana, about 1 volt is generated as a result of 10^{10} gallons flow every sec-

Power Tube Assembly

Typical of the step-by-step sequence of operations in assembling a beam-power, water-cooled RCA tetrode for use in uhf television is that of placing cathodes in position with tweezers. As shown in the photograph, the tool in the left hand is used to depress the pantograph cathode spring to which the cathode is clipped

In the many fields using Iron Powders...

When you seek the utmost in	Try these types of G A F. Carbonyl Iron Powders
I. F. Cores (TV)	TH, SF, J
Permeability Tuner Cores	L, HP, MR, GQ4
I. F. Cores (BC)	E
FM tuning cores	J, W
Core resistivity	J, W
Low modulation and hysteresis	SF
Low modulation, but good permeability	C, GS6
Stability	E, TH, SF
Density	HP
Green Strength	L, HP, MR
Smooth machining	E, TH, SF
Sintering at low temperatures	E
Finest particles	SF, W
Magnetic fluids, dispersibility	E, L
Permeability	HP, GQ4
Purity — for high purity alloys	L

Today there are eleven types of GAF Carbonyl Iron Powders — each produced to rigorous standards of uniformity. Their characteristics vary by type.

Ask your core maker, your coil winder, your industrial designer how these powders can increase the efficiency and performance of the equipment or product you make. They can reduce weight, size, and also decrease cost. If your requirements call for other characteristics or different degrees of performance than are offered by any of our standard types, we welcome the opportunity to work with you in developing new grades of iron powders.

Let us send you literature giving the applications and working properties of GAF Carbonyl Iron Powders. Send for your free copy today.

ANTARA gaf

ANTARA CHEMICALS
A SALES DIVISION OF
GENERAL ANILINE & FILM CORPORATION
435 HUDSON STREET • NEW YORK 14, N. Y.

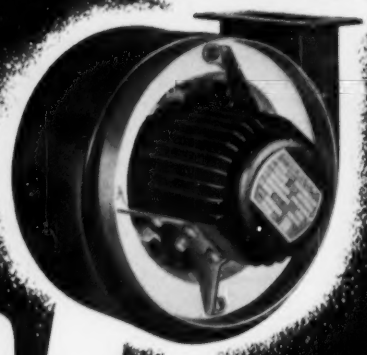
MEMBER mpa METAL POWDER ASSOCIATION

From Research to Reality...

Want more information? Use post card on last page.

TYPE 409
CATALOG SHEET 40102-7

ROTRON
INVERTED
BLOWERS

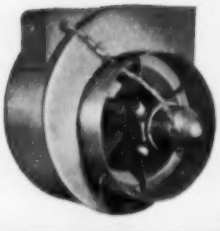


ROTRON

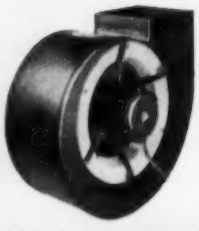
So Compact...
every designer's dream

Rotron inverted blowers are fitted with numerous well conceived inlet and outlet adaptors as well as mounting provisions.

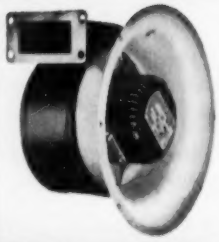
ROTRON
WOODSTOCK · MANUFACTURING CO., INC. · NEW YORK



TYPE 901
CATALOG SHEET RM 169



TYPE 702
CATALOG SHEET RM 162



TYPE 505
CATALOG SHEET 40102-10

ond. However, this voltage varies as a function of the discharge or velocity of ocean-current flow through the Straits. The volume of flow varies by a factor of nearly three.

▶ **Measurements** — Experiments have been carried on since 1952 by physical oceanographers of the Oceanographic Institution at Woods Hole, Mass., using one of the Western Union cables between Key West and Cojimar, Cuba.

In an article in the *Western Union Technical Review* of Jan. 1956, it is suggested that there may be a relation between lower discharge rates and weaker Trade winds and that this might be related, in turn, to a severe hurricane season.

Mobile Tower For TV Remotes

By Joseph Mitchell
Radio Station WFLA
Tampa, Florida

In television broadcasting, the trend is to more on-the-spot and remote pickups. In many cases, since there is no handy place of adequate height to mount the microwave transmitter, some means of getting the transmitter high enough must be built.

To construct a 50-to-80 ft tower or scaffold for this purpose is costly for a single show and also takes considerable lead time ahead of the telecast. A 60-foot heavy duty tower has been designed by E-Z Way Towers, Inc. for getting a signal on the air as quickly as possible without the need of guy stays. It can be operated either on the trailer or on a specially rigged truck.

This tower will support a 4-foot dish and microwave transmitter fully extended in winds up to 15 mph and will have less than 3-degree torsion from side to side. Guys can be used to hold down torsion and sway when greater winds are expected.

A special panning head has been developed, which mounts on the top of the tower. The mounting ring

TI PROGRESS REPORT ON
SILICON SEMICONDUCTORS

Performance

...NOT PROMISES!

TI line of silicon transistors and diodes and stockpile of grown silicon crystals.

TWO YEARS AGO the first silicon transistors were put on the market by Texas Instruments. Enthusiastic acceptance of these high gain, high temperature units has allowed Texas Instruments to repeatedly increase production and reduce prices because of improved mass production techniques.

TODAY, after outstanding field performance under rigorous conditions, TI silicon transistors and diodes are being installed in mass-produced equipment by increasing numbers of electronics manufacturers. You can now select from TI's broad line of silicon transistors . . . the widest choice on the market . . . allowing for *complete* transistorization of many circuits.

THE 8 TYPES of TI grown junction silicon transistors range from high gain, low level units to high gain power units with up to 8.75 watts dissipation. Also, Texas Instruments produces 55 types of single crystal fused junction diodes . . . general purpose diodes in 13 voltage ratings . . . voltage reference diodes in 42 voltage breakdown ratings.

WHEN YOU PLAN transistorization or miniaturization, contact Texas Instruments first . . . your most experienced source for semiconductor devices – silicon or germanium transistors, rectifiers, and diodes.

YOUR CHOICE OF 8 SILICON TRANSISTORS

4 high temperature small signal transistors

For reliability and economy at high temperatures. Dissipation at 150°C, 50 mw; at 25°C, 150 mw. Maximum collector voltage, 30 volts.

type no.	alpha	alpha frequency cutoff (mc)	gain (db) (design center)
903	0.9 to 0.95	4 (Design Center)	30.5
904	0.95 to 0.975	5 (Design Center)	34
905	0.975 (Min.)	6 (Design Center)	36.5
904-A	0.95 (Min.)	8 (Minimum)	35

3 high temperature medium power transistors

For audio and amplifier stages. Dissipation at 150°C, 150 mw; at 25°C, 1 watt.

type no.	alpha (minimum)	collector voltage (maximum)	gain (db) (minimum)
951	0.9	50	30
952	0.9	80	30
953	0.9	120	30

high temperature power transistor

For output power stages, as in servo amplifier outputs. Dissipation at 100°C, 3.5 watts; at 25°C, 8.75 watts.

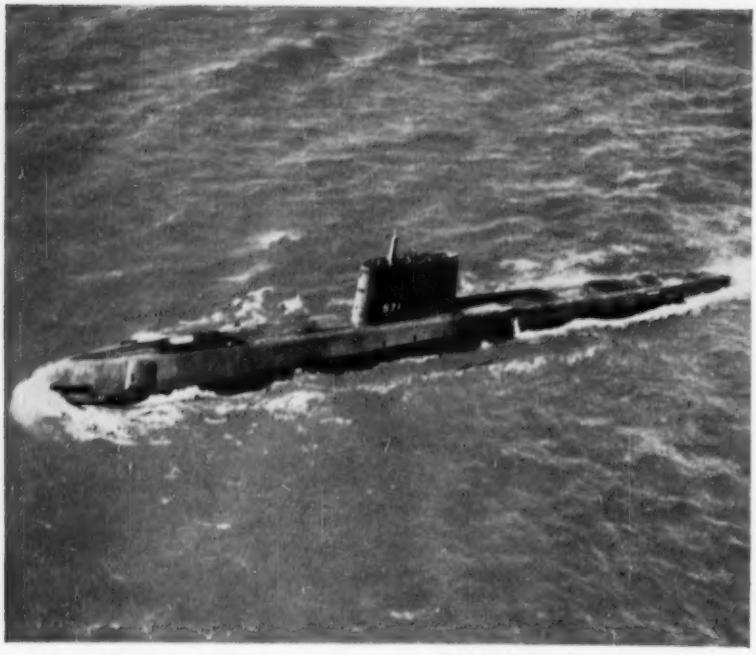
type no.	operation	output (minimum)	gain (db) (minimum)
970	Class A (100°C)	1 watt	28
970	Class B (100°C)	2.5 watts	18

LOOK TO TI FOR: SILICON SMALL SIGNAL AND POWER TRANSISTORS • SILICON JUNCTION DIODES • GERMANIUM RADIO AND GENERAL PURPOSE TRANSISTORS • SWITCHING TRANSISTORS

pioneer producer of silicon transistors

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

Want more information? Use post card on last page.



Official U. S. Navy Photograph

'Diamond H' Aircraft-type Relays Go to Sea in the Nautilus

Their reliability proven in such critical land and air applications as guided missiles, jet engine controls and fire control systems, "Diamond H" miniature, hermetically-sealed, aircraft-type relays were chosen by Westinghouse for an important role in the world's first atomic-powered submarine. They're used in the reactor control system of the Nautilus.

Possible performance characteristics of "Diamond H" Series R 4 PDT relays span such broad ranges that the modifications which can be arranged to meet particular sets of requirements are almost endless. They're fully described in Bulletin R250, a copy of which is yours for the asking. Our engineers will gladly work with you to develop a variation for your specific need.

THE HART MANUFACTURING COMPANY

202 Bartholomew Avenue, Hartford 1, Conn.

for the dish and transmitter bolts on this head and the head can be rotated 380 degrees or tilted 15 degrees below the horizontal or 30 degrees above the horizontal by means of two cranks placed at the base of the tower. This allows panning to be done from the ground.

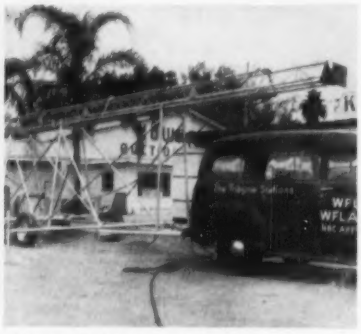


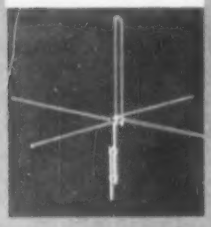
FIG. 1—Trailer carrying tower is located at desired spot. Outriggers keep unit steady while tower is raised in about three minutes

Telescopic shafts are used with this mechanism so that the tower can be raised or lowered to any level without any adjustment to the shafts.

FIG. 2—Panning head and driver shafts. Ring mounted on plate holds transmitter and dish antenna

A second panning head has been developed that will operate two 4-foot dishes with their respective receiver and transmitter; each dish can be rotated 210 degrees and tilted 15 degrees above or below the horizontal. Intended use is at repeater or relay points.

This tower can be loaded on the trailer, pulled to location and set up quickly with the assistance of the trailer and then guyed. The



BARGAINS in POWER

No single piece of radio equipment can equal the antenna for economically increasing effective power.

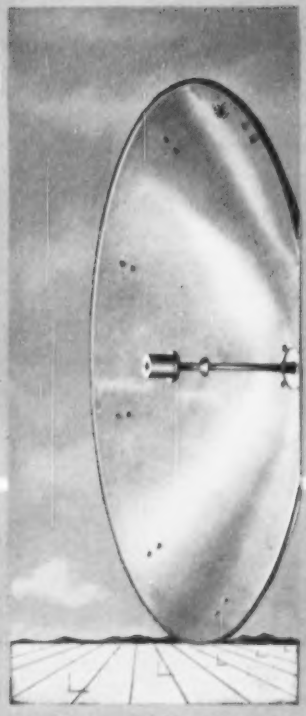
One of the less expensive components in a radio communications installation is the antenna. Yet the antenna, which usually represents less than ten per cent of the total equipment cost, can multiply the effective power of every transmitter in the system *several hundred per cent*. Equally true, a poorly designed or inappropriate antenna can waste the power produced by the costly equipment behind it.

Manufacturers of the UNIPOLE, High Gain, Corner Reflector, Parabolic and Yagi Antennas

In planning a new system, selection of the proper antenna often will allow a lower power transmitter to achieve desired signal range. For existing systems, the use of a higher gain antenna will reduce "dead spots."

Andrew is a pioneer in designing and developing antennas. We make over 30 standard types for microwave, broadcast and mobile communications. Special models or adaptions of standard models are readily made to order.

Write or phone Andrew for a dollars-and-cents evaluation of the type of antenna that can give your installation the greatest bargain in power.



Andrew CORPORATION

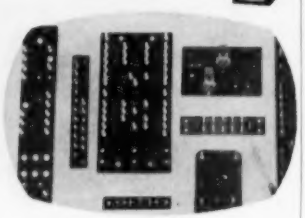
363 EAST 75th STREET • CHICAGO 19

OFFICES: NEW YORK • BOSTON • LOS ANGELES • TORONTO

Standardized Electronic Hardware:

IMMEDIATE DELIVERIES

World's Largest Stock



You get immediate delivery from the largest warehouse stock of silver plated terminal lugs in the world. This means you put your line into production without delay. Over 21 million pieces ready for immediate shipment.

NO JAMMING—No jammed swaging machines nor delays due to off-sized units. USECO'S precision manufacture and quality control guarantees smooth performance. Lugs are specially processed after machining to eliminate distortion.

"USECO-PLATE" – "USECO-PLATE," exclusive silver plating, insures consistent thickness over the entire surface. Meets Federal Specs. Special lacquer dip prevents corrosion, helps solder-bond. Various platings such as gold, cadmium, hot tin dipped, etc., are available on request.

TERMINAL BOARDS—Prompt stock delivery of Standard Boards. Specials to your specifications. All operations under one roof to speed delivery and maintain undivided responsibility.

PRINTED CIRCUITS—"WRAP-AROUND," "PLATED-THRU" and "FLUSH" circuits. Noted for correct plating, extreme accuracy, excellent pattern definition, better contact, easier unplugging —all adding up to guarantee unsurpassed performance.

CATALOGS—See our condensed catalog pages in The MASTER and in ELECTRONIC BUYER'S GUIDE. For more information, write for complete catalog. Please address Dept. 16

U. S. ENGINEERING CO., INC.

A Division of Litton Industries, Inc.

521 COMMERCIAL ST., GLENDALE 3, CALIF.

trailer can then be unbolted from the tower and taken away for other use.

Scenioscope TV Tube

IMAGE orthicon camera tubes are generally used by tv broadcasters in the United States and for European programs in which there would otherwise be a requirement for special lighting.

The image iconoscope is believed in Europe to produce a somewhat superior picture quality at illumination levels above 1,000 lux. (The lux is equivalent to the foot-candle.) Line-by-line clamping becomes necessary from that value down to about 400 to 500 lux. At low levels, the picture is also likely to be affected by noise.

Operation of the Scenioscope tube is most easily explained in terms of the forerunner image iconoscope for which a schematic cross-section is shown.

An image of the scene to be televised is formed by a special lens on a transparent photocathode. Photoelectrons emitted are deflected by both an electric and a magnetic field. They strike points on a mica target corresponding to the image points from which they were emitted. On the target is produced a pattern or

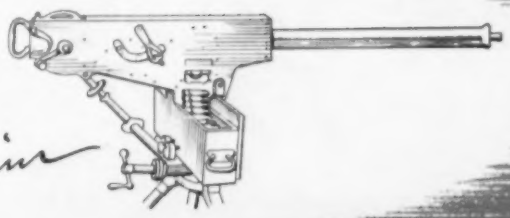
Transistor Two-Way Portable

Among the growing list of transistorized firsts is the Motorola two-way portable communications set that employs transistors in i-f amplifiers and audio stages of the receiver. Battery drain is thereby reduced more than 70 percent

. . . packaged for efficiency

Hiram Maxim devised the first single-barrel, fully automatic machine gun. It embodied the best features of other firearms and Maxim's own refinements. With this automatic, well-packaged gun, one man has the fire power of dozens of individual riflemen.

Hiram Stevens Maxim



FXR BROAD-BAND MICROWAVE SIGNAL SOURCES

with direct reading frequency dial– one-knob control from 950 to 4000 Mc/s

SPECIFICATIONS

Type No. N771A: 950 to 2000 Mc/s.
Type No. N771B: 1900 to 4000 Mc/s.
Direct Reading Frequency Dial Accuracy: ± 1%*
Power Output: 50 mw (average) over the band.
Internal Modulation: CW, Square Wave and Pulse (400 to 1800 cps)
External Pulse Modulation and Reflector Modulation (FM) through Front Panel Input Jacks.

*When greater accuracy is required, the FXR Type No. N410A Direct Reading Coaxial Frequency Meter will provide ± 0.1% accuracy from 1000 to 4000 Mc/s.

Convenience is the "big gun" of the FXR *all-in-one* Signal Sources. Into one compact package has been built a power supply, klystron, klystron cavity, modulator, variable rf attenuator and an automatic reflector voltage tracking system. These Signal Sources are as easy to use as your home radio. The speed and ease with which broad-band measurements may now be made increases efficiency and allows more time for other tasks. Also, the output power across the band is high enough for most attenuation measurements.

Microwave engineers who use the compact FXR Signal Sources will appreciate the valuable time saved, the convenience, improved stability and simplicity of operation of these units. This represents another example of FXR's leadership in contributing to progress in the Microwave Test Equipment Field.

N410A

Write today for a complete catalog of FXR PRECISION MICROWAVE TEST EQUIPMENT.

FXR ELECTRONICS & X-RAY DIVISION F-R MACHINE WORKS, INC.

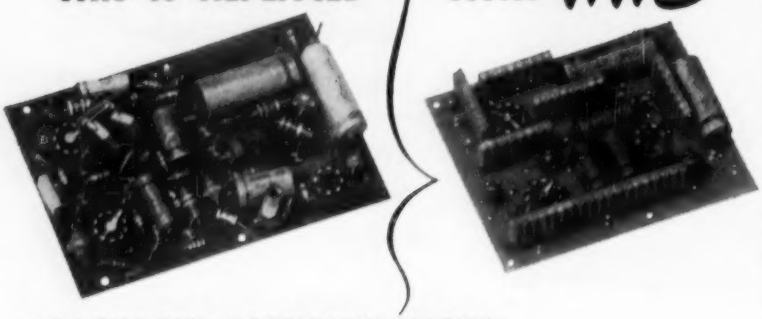
FIRST BY FAR

Electronics & X-Ray Division

F-R MACHINE WORKS, Inc.

26-12 BOROUGH PLACE, WOODSIDE 77, N. Y. • ASTORIA 8-2800

THIS IS REPLACED WITH THIS



*PACKAGED ASSEMBLY CIRCUIT

PAC-Facts

REDUCED COSTS
PAC requires fewer insertions. Simplified equipment. Smaller chassis area. Reduced inspections. Fewer items purchased. Fewer chassis holes. Simplified chassis wiring.

UNIQUE TERMINAL DESIGN
The Erie PAC terminal provides a "U"sheped cross section and tapers in both planes to assure easy insertion, self-adjusting — rigid fit, and large contact area.

FLEXIBILITY
All Resistance values between 5 ohms and 50 megohms. Wide range of capacitor temperature characteristics. Parallel and series arrangements readily obtained. Excellent circuit flexibility thru use of printed wiring type base.

REDUCED CHASSIS AREA
Chassis area is reduced by use of the vertical plane design feature. 15 components per square inch.

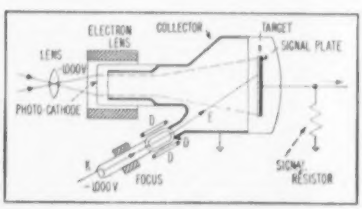
Erie's new Packaged Assembly Circuit is able to reduce assembly and labor costs for electronic component users by simplifying automation. By employing standard size resistor and capacitor pins, a PAC module can be assembled simply, automatically, and economically.
PAC will drastically reduce the number of component insertions in TV, radio, computers, and other electronic equipments by combining up to 90 components into one PAC module. The illustration above clearly exemplifies how Erie's Packaged Assembly Circuit will clean up and simplify nearly any printed circuit board. The original conventional design, at left, contains 44 individual components. The electrically equivalent Erie PAC design, at right, contains but 16 individual units — *a savings of 64% in the number of insertions.*
Experimental PAC Design Kits have been prepared and are available at a moderate cost. The 5% PAC Kit includes 195 different resistance and capacitance values, strips, wiring boards, clips, eyelets, and other material essential for building complete PAC circuits. The 10% PAC Kit contains 105 values along with the other items, and the 20% PAC Kit has 54 values plus equipment. This Design Kit is your key to cost savings.

Write for Erie Engineering Bulletin No. 450-1

ERIE electronics
ERIE ELECTRONICS DIVISION
ERIE RESISTOR CORPORATION
Main Offices and Factories: ERIE, PA.
Manufacturing Subsidiaries
HOLLY SPRINGS, MISSISSIPPI • LONDON, ENGLAND • TRENTON, ONTARIO

image of positive charges that is then scanned by an electron beam.

As they are scanned in sequence, the separate picture elements assume a potential corresponding to a secondary-emission factor of unity. Between consecutive scannings, the potential of the individual target elements drops owing to the fact that they intercept slow secondary electrons released from other points on the target by the fast photoelectrons and the equally fast electrons of the scanning beam. This interception effect is known as redistribution. As potential decreases it is increasingly probable that photoelectrons will release secondary electrons from a particular target element.



Cross-section of image iconoscope showing deflection coils *D* and scanning beam *E*. In the new tube, the insulated mica target plate is replaced by a conducting glass plate

Essential difference between the image iconoscope and the Scenioscope lies in the target. This comprises a glass plate having a certain conductivity. It is substituted for the insulating mica plate employed in the image iconoscope.

The back is covered with a layer of metal that acts as the signal plate. It assumes a negative potential with respect to the collector. The scanning beam periodically stabilizes the surface elements of the target at a potential slightly higher than that of the collector.

The potential of a particular element drops in the interval between successive scannings, partly because of interception of redistribution electrons. Main cause of the drop is leakage current through the target. Dominance of leakage current as compared with redistribution tends to eliminate spurious signals.

Signal versus photocurrent in the new tube has a curvature opposite to that of luminance versus control characteristic of a picture tube,

Sustained electrical accuracy throughout the life of a potentiometer is largely governed by the unit's ability to resist mechanical dimensional changes. The all-metal-case construction of Fairchild potentiometers assures mechanical rigidity that maintains superior initial accuracies and tolerances throughout a long life cycle—in spite of severe changes in environmental conditions. This is another advance made possible by Fairchild's continuous research and quality control program on materials, processes and manufacturing.

SUSTAINED ACCURACY

through mechanical rigidity

Now for the first time Fairchild brings you the sustained accuracy of all-metal-case construction in a 10-turn potentiometer. This unit has only ½ the diameter and ⅓ the weight of usual standards. It is the Fairchild Standard Type 920. Its 24½" coil length assures linearities of ±0.25% in a resistance range of 1,000 to 200,000 ohms, with ±0.1% available for special applications. Your choice of servo, threaded bushing or three-hole pilot bushing mountings.

This is another example of how Fairchild's complete line can give you the answers, no matter what factors govern your choice of precision potentiometers. Write Fairchild Controls Corp., Components Division. Dept. 140-62A2.

EAST COAST
225 Park Avenue
Hicksville, L.I., N.Y.

WEST COAST
6111 E. Washington Blvd.
Los Angeles, Cal.

FAIRCHILD
PRECISION POTENTIOMETERS and COMPONENTS

TIME... for "flight – vital" ground installations

HAYDON* 7008 SERIES ELAPSED TIME INDICATOR

Now available for 60 cycle operation

Now available for 60 cycle as well as 400 cycle operation, HAYDON 7008 Series Elapsed Time Indicators retain the same important features of high quality, extreme dependability, compactness and light weight. Here is the ideal means of providing precise, fully reliable timing for the many types of vital, permanent or portable ground installation equipment that require an accurate record of running time for correct maintenance and assured functioning.

On the ground or in the air — wherever performance demands sky-high timing standards — count on HAYDON. Write today for Engineering Bulletin No. 5 describing the new 7008 Series Indicator for 60 cycle operation . . . and for catalogs describing the complete lines of HAYDON Timing Motors and Devices. Or contact the HAYDON Field Engineer located near you.

*Trademark Reg. U.S. Patent Office

HAYDON AT TORRINGTON
HEADQUARTERS FOR TIMING

A SUBSIDIARY OF GENERAL TIME CORP.

HAYDON Manufacturing Company, Inc.
2428 ELM STREET, TORRINGTON, CONNECTICUT

which eliminates need for gamma correction. A picture of acceptable quality is now obtained with only 100 lux of illumination on the scene. A value of 300 lux is sufficient to insure a virtually noise-free picture.

This information has been abstracted from *Philips Technical Review*, courtesy of North American Philips Co., Inc.

Phonetic Alphabet Changes

STARTING March 1, CAA controllers abandoned use of the phonetic words, COCA, METRO, NECTAR, UNION and EXTRA and substituted CHARLIE, MIKE, NOVEMBER, UNIFORM and XRAY.

These changes have been approved by the International Civil Aviation Organization (ICAO) after tests showed that the five words now replaced were causing confusion.

The latest international phonetic alphabet is

ALFA	NOVEMBER
BRAVO	OSCAR
CHARLIE	PAPA
DELTA	QUEBEC
ECHO	ROMEO
FOXTROT	SIERRA
GOLF	TANGO
HOTEL	UNIFORM
INDIA	VICTOR
JULIETT	WHISKEY
KILO	XRAY
LIMA	YANKEE
MIKE	ZULU

Tube Information Service

NATIONAL Bureau of Standards has on file some 10,000 cards filed by tube type number and appropriately referenced to manufacturers' source material. About 10 percent of the cards, representing more popular types of tubes, have been coded on punched card for mechanical sorting.

With this service it is possible to find information on any tube, all tube types whose electrical characteristics, bulb sizes or base configurations fall within particular

A. Louis Oresman, President of Catalina, Inc., asks

"Can you pick the winner?"

"The bathing suit business is like a beauty contest. You never can tell in advance which models are going to win!

"This year, for example, we designed more than 400 different suits. Those that catch on in the stores get a flood of rush orders! They push our production facilities to the utmost. And that, in turn, puts the pressure on shipping and delivery.

"But even though our manufacturing is done in the Los Angeles area, we never have delivery problems anywhere in the 48 states! They're all solved for us by Air Express! And Air Express has never failed us!

"Using Air Express regularly, we can fill rush orders anywhere in the country in a matter of hours. And in the highly competitive fashion business, that's important!

"And yet, most of our shipments cost less than any other air service. 10 lbs., for instance, Los Angeles to Dallas, is $5.70. It's the lowest-priced complete air service by 81¢!"

Air Express

GETS THERE FIRST *via U.S. Scheduled Airlines*

CALL AIR EXPRESS . . . *division of* RAILWAY EXPRESS AGENCY

TOWER FOOTING INSULATORS FOR SELF-SUPPORTING RADIATORS

LAPP

ANTENNA TOWER

INSULATORS

MAST BASE INSULATORS

RADIO GUY INSULATOR

We at Lapp are mighty proud of our record in the field of tower insulators. Over 30 years ago, the first insulated broadcasting tower was erected—on Lapp insulators. Since then, most of the large radio towers in the world have been insulated and supported by Lapp insulators. Single base insulator units for structures of this type have been design-tested to over 3,500,000 pounds.

A thorough knowledge of the properties of porcelain, of insulator mechanics and electrical qualities has been responsible for Lapp's success in becoming such an important source of radio insulators. Write for description and specification data on units for any antenna structure insulating requirement. Lapp Insulator Co., Inc., Radio Specialties Division, 248 Sumner Street, LeRoy, N. Y.

Lapp

ranges and domestic tubes that can be substituted for foreign types.

The service is now available to scientists and engineers in government and industry who have legitimate requests. Coding on punched cards is proceeding as rapidly as possible for the balance of the data.

Inquiries can be made by telephone. Written requests should be addressed to C. P. Marsden, Chief, Electron Tubes Section, National Bureau of Standards, Washington 25, D. C.

Microammeter Measures Frequency

AUDIO-FREQUENCY measurements can be made with considerable precision at the lower end of the spectrum using a saturable reactor and a rectifier. A plug-in unit that has been developed recently combines components and requires only a suitable source of voltage and a microammeter to give direct frequency readings.

The magmeter is essentially a saturable reactor that serves as a volt-second limiter providing constant output pulses for each reversal of the input signal. These pulses are rectified and delivered to a d-c microammeter to provide output indication. The character-

Plate Photocontrol

A new printer for making presensitized offset plates is controlled automatically by a photoelectric device. Manufactured by Robinson Photomechanix, Inc., it can also be used for albumen and deep-etch plates or with sensitized papers. An etched circuit is employed in the electronic control unit

THERE ARE NONE FINER!

TRU-OHM Power RHEOSTATS

TRU-OHM POWER RHEOSTATS are more and more in demand and there are many reasons. These include finest quality, better service, and delivery; UL approval; variety from 25 watts up; fairest prices; AND TRU-OHM expedites for YOU . . . TRU-OHM ships on time.

We invite your inquiry.
Have you received our latest catalog? WRITE TODAY!

TRU-OHM PRODUCTS

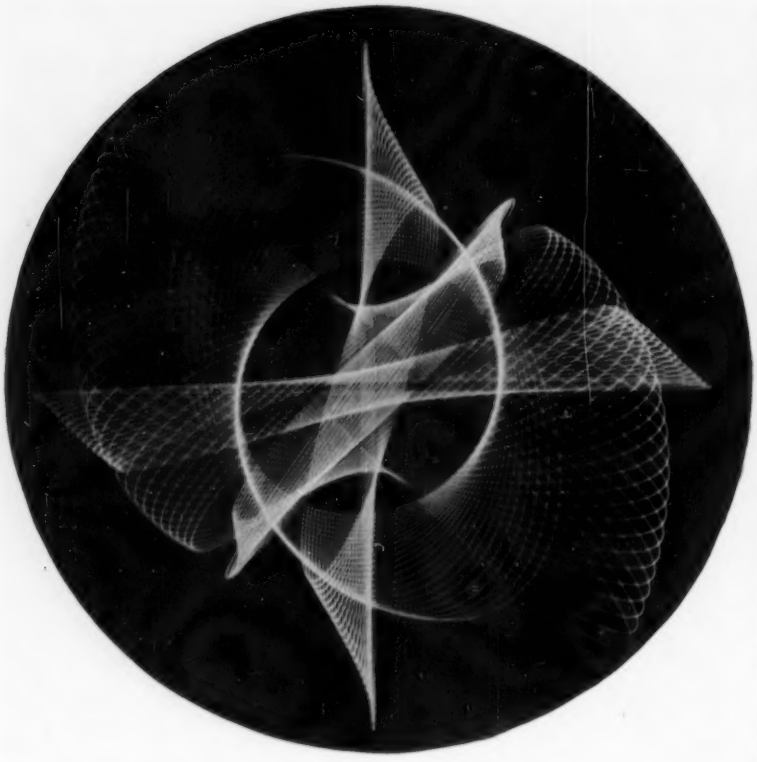
Division of Model Engineering & Mfg., Inc.

General Sales Office: 2800 N. Milwaukee Avenue, Chicago 18, Ill.

Factory: Huntington, Indiana

"Largest producers of wire-wound resistors in the U.S.A."

MANUFACTURERS: Power Rheostats · Fixed Resistors · Adjustable Resistors · "Ironclad" Resistors · "Tru-Ohm" Resistors



are you "lost" in electronics?

Developments have been so rapid in the horizonless science of electronics that many creative engineering talents lie hidden "under a bushel" of non-creative detail work.

If your ability exceeds the use that is now being made of it, you'd do well to learn what's happening at Martin.

For there are—and always will be—excellent opportunities at Martin for electronics engineering talent in the fields of aircraft, missiles, rocketry, nucleonics and space vehicle development.

Contact J. M. Hollyday, Dept. E-04, The Martin Company, Baltimore 3, Maryland.

MARTIN
BALTIMORE

istics of the core material on which the reactor is wound are essentially invariant with time and temperature.

The basic unit lends itself to applications over wide frequency ranges. At low frequencies of 1 to 20 cps it can be used for measurements in which counter-type instruments tend to be inconvenient because they require about 10 seconds for their indications to obtain an accuracy of at least 5 percent.

▶ **Aircraft Use**—In a typical application, the frequency range is from 0 to 500 cps when used with a 0-500 microampere meter. Where limited signal is available, a vacuum-tube driver (Fig. 1) is used. In this application the frequency detector has a linearity of better than 2 percent of full scale (±10 cps) plus a temperature coefficient up to 550 parts per million per degree centigrade.

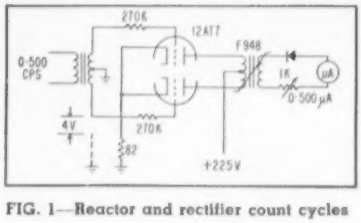


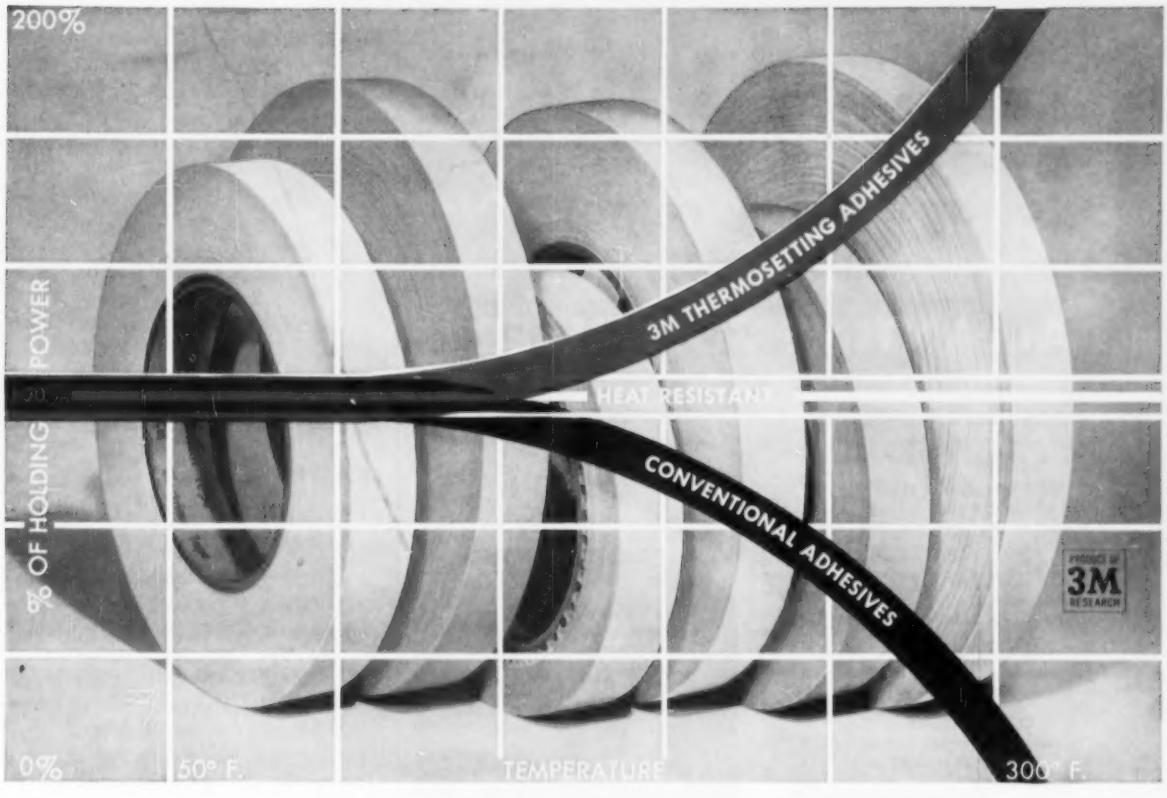
FIG. 1—Reactor and rectifier count cycles

When the input signal is 4 volts rms across each half of the input transformer, a 25-percent change in excitation produces less than 1-percent change in frequency indication. Minimum reliable drive at this point in the circuit is 2 volts rms; maximum safe drive is 6 volts rms.

Response of the magnetic frequency detector is essentially independent of wave form. There is less than 1-percent change in indication for sine, square, or triangular waves having the same rectified average value.

In the circuit shown, the 12AT7 dual triode draws an average current of 15 ma. Interchanging tubes produce less than 1-percent change in output.

▶ **Operation**—The input transformer matches the driver stage to the low-power signal source whose frequency is to be measured. The bias resistor develops self-bias for



These curves tell a straight story!

Do you find such insulation adhesive terms as *thermosetting*, *heat-resistant*, and *solvent-resistant* confusing at times? For instance, the difference between a pressure-sensitive tape with a "thermosetting" adhesive and one with "heat-resistant" adhesive?

The difference in holding power of the two is graphically demonstrated in the chart above. A "heat-resistant" adhesive simply has a higher-than-average softening point. For many applications, where not subjected to high temperatures, tapes with conventional or heat-resistant adhesives may offer adequate holding power. But if extreme or prolonged temperature is the problem, you need "SCOTCH" Brand Tapes with 3M *Thermosetting* Adhesive.

The "thermosetting" adhesive on "SCOTCH" Brand Tapes is soft enough at application to be pressure-sensitive — tapes stick at a touch. When subjected to heat, however, a positive chemical change takes place which *increases* the adhesive's bond strength — it develops into a firm, insoluble, infusible bond.

Once cured, 3M Thermosetting Adhesive holds under extreme operating heat without softening . . . has high bond-strength for anchoring leads . . . bakes dry to prevent throw-out . . . resists action of solvents, waxes, and varnishes. The only tapes combining all four of these advantages are "SCOTCH" Brand Tapes with 3M Thermosetting Adhesive.

Why not let us show you how 3M Thermosetting Adhesive Tapes can give better performance in insulating your products? Just write on your letterhead to 3M Co., St. Paul 6, Minn., Dept. CA-46.

These "Scotch" Brand Insulating Tapes have 3M Thermosetting Adhesive: No. 27, Glass Cloth Backing; **No. 28,** Acetate Cloth Backing; **No. 29,** Cotton Cloth Backing; **Nos. 38 and 39,** Treated Paper Backings; **No. 56,** Polyester Film Backing.

The first true thermosetting adhesive . . . still the industry standard . . . found only in . . .

REG. U.S. PAT. OFF.
SCOTCH BRAND **Electrical Products**

The terms "SCOTCH" and "3M" are registered trademarks of Minnesota Mining and Manufacturing Co., St. Paul 6, Minn. Export Sales Office: 99 Park Ave., New York 16, N.Y. In Canada: P.O. Box 757, London, Ontario.

INFRASONIC

(Ultra-Low Frequency per I.R.E. "Standards on Electroacoustics, 1951")

Voltage Measurements

with the NEW

BALLANTINE VOLTMETER

MODEL 316

FREQUENCY RANGE
0.05cps to 30KC
down to 0.01cps with corrections

VOLTAGE RANGE
0.02 to 200V peak to peak
lowest reading corresponds to
7.07mv rms of a sine wave

ACCURACY
3% throughout ranges
and for any point on meter

IMPEDANCE
10 megohm by an average
capacitance of 30 μμf

OPERATION
Unaffected by line variation
100 to 130V, 60 cycle, 45 watt

APPLICATIONS

The Ballantine Infrasonic Voltmeter Model 316 has been introduced to satisfy a growing need for an instrument to facilitate the measurement of ultra-low frequency potentials as are encountered in low frequency servomechanisms, geophysics, biological research, and in loop analysis of negative feedback amplifiers. Among many other uses, it will serve as a very satisfactory monitor for the output of commercially available ULF signal generators most of which are not fitted with an output indicator.

PRICE: $290

FEATURES

- Pointer "flutter" is almost unnoticeable down to 0.05cps, while at 0.01cps the variation will be small compared to the sweep observed when employing the tedious technique of measuring infrasonic waves with a dc voltmeter.
- A reset switch is available for discharging "memory" circuits in order to conduct a rapid series of measurements.
- The reading stabilizes in little more than 1 period of the wave.
- Meter has a single logarithmic voltage scale and a linear decibel scale.
- Accessories are available for range extension up to 20,000 volts and down to 140 microvolts.

For further information on this and other Ballantine instruments write for our new catalog.

BALLANTINE LABORATORIES, INC.

100 FANNY ROAD, BOONTON, NEW JERSEY

the dual triode. Bias is such that on positive peaks, the grids draw current.

The 270-ohm limiting resistors clip these peaks so that the reactor unit will not be overdriven. The 1,000-ohm compensating rheostat is initially adjusted with an input of known frequency to produce the correct indication on the meter. The unit weighs 3½ ounces. Information on the circuit has been furnished through courtesy of Airpax Products Co.

F-M Transistor Transmitter

BUILT to demonstrate practical vhf performance of transistors, the f-m transmitter described briefly here occupies a volume of 3½ cubic inches. The essential components in the small device require only a plastic case and compact battery for completion of a working unit.

Only one transistor, shown in the figure, is used. As an r-f oscillator, the transistor operates by virtue of energy fed back through interelement capacitances. Characteristics of the transistor provide an effective phase shift that compensates for that resulting from capacitive feedback.

The transmitter is made to operate in the region of 100 mc principally because of the convenience in obtaining receiving equipment at this frequency. It is adjusted to a channel not occupied by a commercial f-m station.

The mechanism of frequency modulation lies in the characteristic current-gain and phase-shift behavior of the transistor. The d-c operating point is defined by d-c emitter current and d-c collector voltage when no audio signal is applied. If this d-c operating point is changed, there will be a phase shift in fed-back energy.

The oscillator will therefore change frequency by the amount necessary to restore the necessary phase relationship and will continue to oscillate, but at a different frequency. When the operating point is varied at an audio rate, the oscillator will be frequency modulated.

The diode in the base circuit permits stable operation using only one

Consult CHATHAM for all four

including tubes, aircraft conversion equipment, selenium rectifiers and radar components. Illustrated bulletins sent on request.

CHATHAM TYPE 5949/1907

Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 6.25 megawatts.

CHATHAM TYPE VC-1258

Zero bias miniature thyratron for generation of peak pulse power to 10 KW. Available with 28 volt heater, ruggedized for extreme vibration.

1 *HIGH PERFORMANCE*

HYDROGEN THYRATRONS

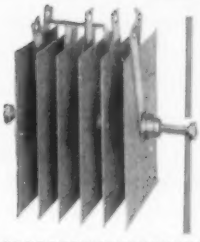
Years of experience in the design and production of these special types have resulted in tubes that offer superior service in the generation of pulse voltages in the order of microseconds.

CHATHAM TYPE 5948/1754

Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 12.5 megawatts.

CHATHAM TYPE VC-1257

Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of pulse power up to 33 megawatts.



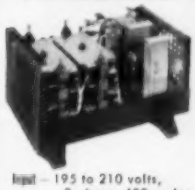
2 *LIGHTWEIGHT CHATHAM "kotron"*

SELENIUM RECTIFIERS

Both electrically and mechanically, Chatham kotron Selenium Rectifiers offer important design advantages. Combining lighter weight with smallest efficient size, kotrons are built rugged to last longer. Improved design assures longer short circuit loads, twice the voltage surge of ordinary rectifiers.

3 *ADVANCE DESIGNED*

AIRBORNE CONVERSION EQUIPMENT



Input – 195 to 210 volts, 3 phase, 400 cycles
Output – 28 v. DC, 100 amps.
Regulation – 25 to 31 volts
Weight – under 17 lbs.

Type 28V100 Power Supply illustrated provides substantial weight savings, reduced size, greater reliability and improved electrical characteristics. Ruggedized throughout. Type 28V-100 exceeds MIL-P-7212 requirements.

4 **CUSTOM-DESIGNED EQUIPMENT**

CHATHAM specializes in the development, design and production of equipment built to customers' needs. Our engineers will supply estimates on receipt of your drawings and specifications.

High power Radar modulators built to government specifications.

IF YOU HAVE A PROBLEM — Chatham facilities are available for the solution of problems involving tubes and special equipment for industrial and military applications. Your inquiry will receive prompt attention.

CHATHAM ELECTRONICS

LIVINGSTON, NEW JERSEY

Division of Gera Corporation

Relay Sales

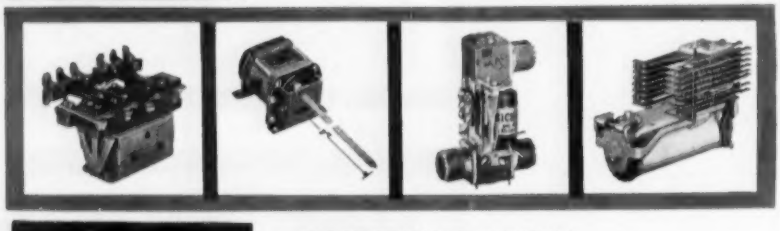
Telephone Relays
Midget Relays
Keying Relays
Rotary Relays
Sealed Relays
Sensitive Relays
Latching Relays
Stepping Relays
Delay Relays
Timers
Contactors
Motor Starting Relays
Differential Relays
Polarized Relays

RELAYS NOW!

Your immediate needs for one or more relays of any kind are shipped from our greatly enlarged stock which includes hundreds of types in all popular contact arrangements and coil ratings.
Complete stocks of current standard types of leading manufacturers are maintained for your convenience.
All relays are new, inspected and unconditionally guaranteed to be as represented. 24 hour delivery is routine. Phone us.

Distributors For
ADVANCE RELAYS

All standard distributor types of Advance Relays are on hand in quantity. Save precious time — order from Relay Sales!

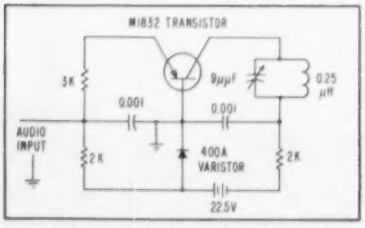


Write for Relay Sales Catalog C-7

MORE THAN A MILLION DEPENDABLE RELAYS IN STOCK
Products of the following well-known manufacturers are represented: Advance, Allied, Automatic Electric, Clare, Cutler Hammer, G.E., Guardian, Leash, Philtrol, Potter Brumfield, Price Bros., RBM, Sigma, Struthers Dunn, Terado, Western Electric and many others.
Write, wire or phone for immediate quotations.

Phone West Chicago 1100

RELAY SALES
P.O. Box 186-A Route 64 at E.J. & E. R.R.
West Chicago, Illinois



Circuit of simple f-m transistor transmitter originally described in ELECTRONICS, p 130, Feb. 1954

battery for emitter and collector circuits. The 3,000-ohm resistor prevents undesirable oscillation and the 2,000-ohm resistor (left) provides a path for emitter current without shorting the audio signal. The other 2,000-ohm resistor (right) adjusts d-c voltage on the collector and acts as load resistance in the audio circuit.

Distance covered with the transmitter, using only radiation from the coil of the oscillator circuit, is limited to a few hundred feet. One practical use for such a unit is in conjunction with a lapel microphone and a public address amplifier, leaving the speaker free to roam at will without dragging a microphone cord behind him.

More complete details of the device have been published in the *Bell Laboratories Record*, Feb. 1956, from which this abstract was made with permission.

Hot Dials

ELECTROLUMINESCENT dials have found their way into automobile radio receivers, where, according to the diagram in one service manual, they are caused to glow using 210 volts a-c from the secondary of the vibrator transformer.

A measure of protection would seem to be afforded the user or service man by virtue of a gap, one side of which is connected to the back of the dial scale, the other being at high voltage. The front of the dial scale is grounded.

In the same brochure, it is indicated that some receivers have a 270,000-ohm resistor in series with the high-voltage lead. The value of this resistor can be changed to vary the brilliance of the scale illumination.

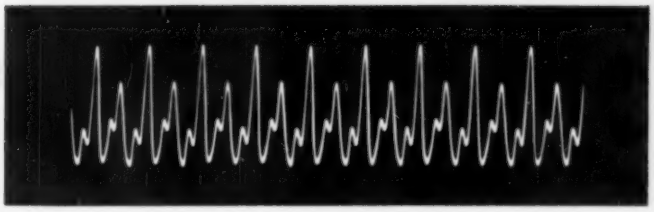
An intrstng exprmnt in spch

Some day your voice may travel by a sort of electronic "shorthand" when you telephone. Bell Laboratories scientists are experimenting with a technique in which a sample is snipped off a speech sound—just enough to identify it—and sent by wire to a receiver which rebuilds the original sound. Thus voices can be sent by means of fewer signals. More voices may economically share the wires.

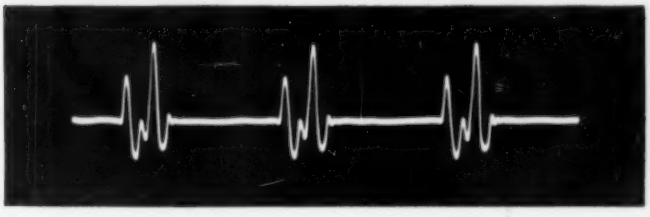
This is but one of many transmission techniques that Laboratories scientists are exploring in their search for ways to make Bell System wire and radio channels serve you more efficiently. It is another example of the Bell Telephone Laboratories research that keeps your telephone the most advanced on earth. *The oscilloscope traces at right show how the shorthand technique works.*

BELL TELEPHONE
LABORATORIES

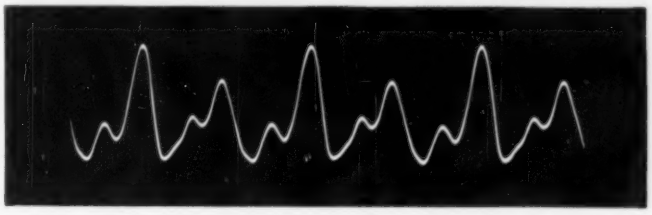
World center of communications research
Largest industrial laboratory in the United States



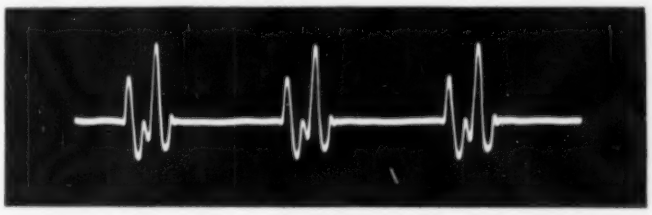
Vibrations of the sound "or" in the word "four." Pattern represents nine of the "pitch periods" which originate in puffs of air from the larynx when a word is spoken.



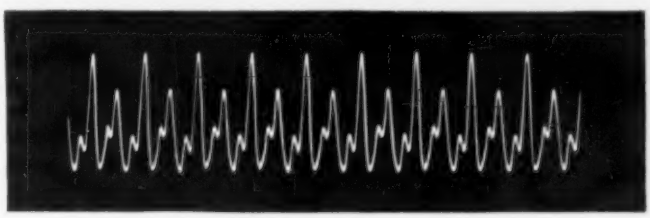
An electronic sampling of the "or" sound. One "pitch period" in three has been selected for transmission. This permits great naturalness when voice is rebuilt. Intelligible speech could be sent through a 1 in 6 sampling.



The selected samples are "stretched" for transmission. They travel in a narrower frequency band than complete sound.



Using the stretched sample as a model, the receiver restores original frequency. In all speech, sounds are intoned much longer than is needed for recognition—even by the human ear. Electronic machines perform recognition far faster than the ear.



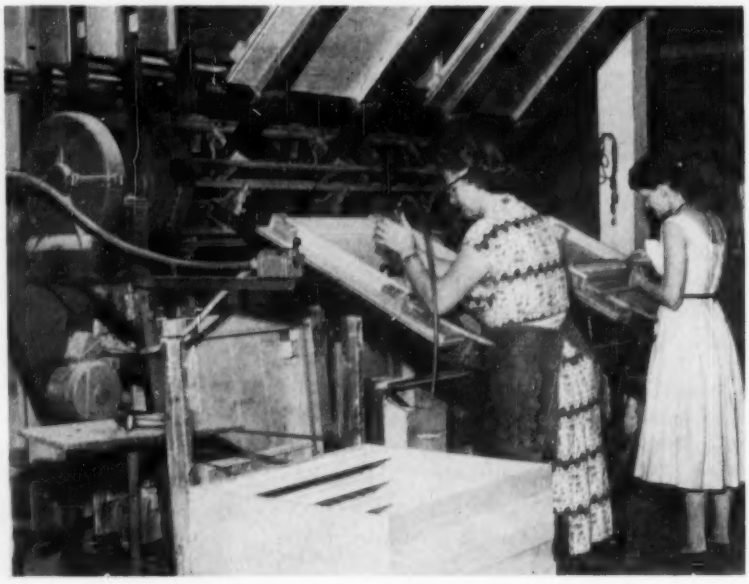
The receiver fills in gaps between samples, recreating total original sound. Under new system, three or four voices could travel at once over a pair of wires which now carries only one—and come out clearly at the end!

Production Techniques

Edited by JOHN MARKUS

Glue-Drying Machine for Television Receiver Cabinet Frames

WOOD FRAMES for fronts of wood-and-metal television receiver cabinets are assembled and dried on a huge revolving-carrier clamping machine at the G-E Rockford, Ill. cabinet plant. The frames are glued and placed in the captive wood clamps for installation of screws. The completed frames then move over the top, down and back underneath the long horizontally mounted drying machine to the starting position while the glue dries. Two sets of clamps are on each carrier, so frames can go through two at a time.



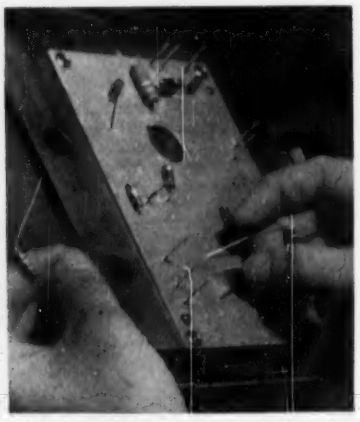
Installing screws after loading glued frames onto carriers of horizontal endless-chain clamping and drying machine. Crank handles of clamps are at outer ends of carriers

Cutting and Clinching Machine for Etched Wiring Boards

A SIMPLE air-operated machine is widely used in RCA's Bloomington, Ind. plant to cut and clinch leads of components automatically after they have been manually inserted in etched wiring boards. These set-ups eliminate the need for preliminary preparation of components, since the operator can bend the leads with her fingers as she inserts them in the holes in the board.

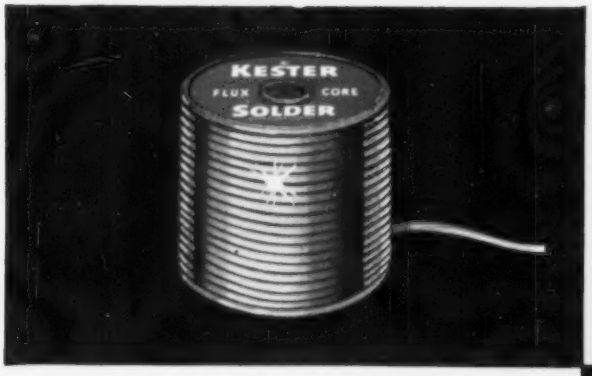
Each operator inserts only a specified group of parts, just as in a conventional manual assembly line. Boards are transferred from

Cutting and clinching blade of machine. Holes in plate under blade serve as cutting die for shearing action



Method of loading components into wiring board on cut-and-clinch machine. Operator bends leads herself

Bringing up lever to press down newly inserted components preparatory to cutting and clinching



going...

going...

gone!

KESTER "44" RESIN, PLASTIC ROSIN AND "RESIN-FIVE" FLUX-CORE SOLDERS owe their production line popularity to the simple fact that they provide the exactly right solder for every soldering application. It's not difficult to realize why Kester is consumed so rapidly . . . because of its great adaptability to so many different soldering operations.

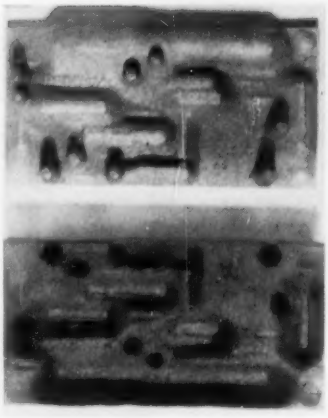
***SEND TODAY** for Kester's new 78-page informative textbook "SOLDER . . . Its Fundamentals and Usage."*

KESTER SOLDER COMPANY

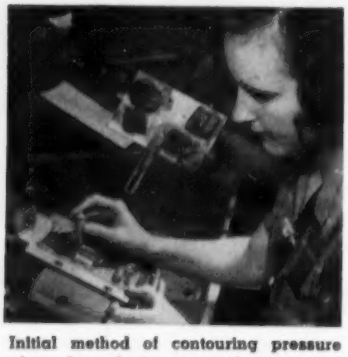
4204 Wrightwood Avenue, Chicago 39, Illinois; Newark 5, N. J.; Brantford, Canada

one station to the next by a conveyor belt that runs under the cut-and-clinch machines. Taking a board off the belt, the operator places it over positioning pegs on the machine, then loads in her assigned components one by one. Next, with her right hand she brings up a lever that presses a rubber-cushioned plate down over the board. This plate has appropriate recesses and cushions to press the newly loaded parts down without crushing them and damaging previously inserted parts.

Pressure on a foot pedal then operates the air cylinder of a Speedy Air Vise to move the shearing blade down toward the operator. This blade cuts all leads simultaneously. Further movement bends the cut ends down against the etched wiring. Contoured recesses in the shearing blade give a neat clinch without crushing the board. A slanting trough collects the cut leads and guides them down into a scrap box on the far side of the belt.



Aluminum mold (top) and sponge rubber pressure pad made from it for use in holding components down on wiring board while cutting and clinching leads



Initial method of contouring pressure plate by glueing carved pieces of sponge rubber in position

Initially, the rubber hold-down pads were made by carving pieces of sponge rubber and cementing them in appropriate positions on a metal plate. Increasing use of the highly successful cut-and-clinch machines justified changeover to a casting technique. For each machine, a board having the parts correctly assembled on it is plastered with modeling clay in the reverse of the desired rubber pad. This board is then used as a pattern in a sand mold for pouring an aluminum mold. The aluminum mold is used in turn as the master for producing as many rubber pads of that pattern as are desired. This is done by placing a sheet of uncured sponge rubber over the aluminum and then curing under heat and pressure much as when making rubber stamp pads. The resulting contoured rubber pieces are then cemented to the metal pressure plates.

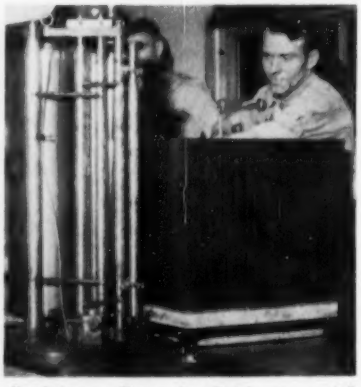
Newer versions of these cut-and-clinch machines use a vertically mounted air cylinder to bring down the pressure pad, speeding up the operation still more. The two air cylinders are interlocked, so that one touch of the foot valve operates them both in sequence.

Setup using overhead pressure pad having its own air cylinder

Finishing Techniques for Wood-Metal TV Cabinets

ACCURATE MATCHING of simulated and actual wood finishes on combination wood-metal television receiver cabinets is achieved at the G-E Rockford, Ill. cabinet plant, by combining roller-graining and electrostatic painting with final hand spray gun touchup.

After receiving the prime finish coat, the metal cabinet shells that form the sides and top of each table-model cabinet are moved by overhead conveyor to the roller-grain room. Here the cabinets are transferred manually to wheeled pallets that can easily be slid along a metal-top bench. Each finished face of the cabinet in turn is rolled past the roller-grain units mounted vertically at the rear of the bench, for application of the simulated wood finish to the metal panels forming the sides of the cabinet.



Applying roller-grain finish to metal cabinet shelves

▶ **Spray Disk**—After draining, the metal cabinet shells are loaded on another overhead conveyor for transport through a Ransburg electrostatic paint station, to receive a clear scuff and stain resistant finish. The shells travel around this room in a circular path on the conveyor while the rotating-disk painting fixture moves up and down in the center of the room. As the paint comes out of the center of the rotating disk, it is electrostatically charged to a high positive potential. The centrifugal force of the disk combined with the attraction of the

Cutaway of "Dual Seal" coil shows penetration of crevices by encapsulating compound based on BAKELITE Epoxy Resin. Encapsulation is by **Deluxe Coils, Inc.**, Wabash, Ind., for **Furnas Electric Co.**, Batavia, Ill.

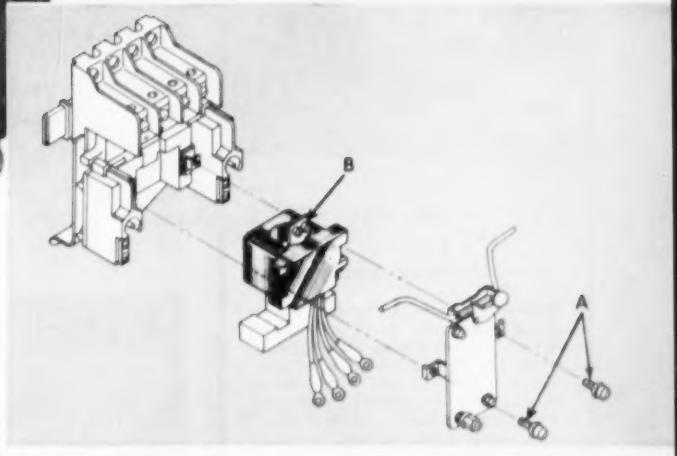
Encapsulated in epoxy resin

One coil replaces six!

A single 220-440 volt dual voltage coil encapsulated in BAKELITE Brand Epoxy Resin takes the place of six coils usually needed in 3, 7½, and 10 hp. starters. It virtually eliminates coil changing, reduces stocking of coils and starters.

The BAKELITE Epoxy Resin encapsulation is extremely tough. It resists moisture, fungus, and aging; cuts moisture-caused burnout almost to zero. The tough resin prevents damage by vibration or impact. It withstands temperatures from —90 to +250 deg. F., and results in a motor that runs eight per cent cooler. Dielectric strength of the resin is high.

Encapsulation with BAKELITE Epoxy Resin is effected by mixing the liquid resin with its liquid hardener and pouring the mixture into place. It penetrates every crevice, then hardens into a tough, dimensionally stable mass that holds each element of the assembly firmly in position.



New coil design has stretched mechanical life of starter more than 50%. Extracting two bracket screws "A" and loosening of cross arm screws "B", as shown in exploded drawing, make coil removal easy.

BAKELITE BRAND EPOXY RESINS

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

Designed for
Application

The No. 90901
One Inch
Instrumentation Oscilloscope

Miniaturized, packaged panel mounting cathode ray oscilloscope designed for use in instrumentation in place of the conventional "pointer type" moving coil meters uses the 1" 1CP1 tube. Panel bezel matches in size and type the standard 2" square meters. Magnitude, phase displacement, wave shape, etc. are constantly visible on scope screen.

JAMES MILLEN MFG. CO., INC.
MAIN OFFICE AND FACTORY
MALDEN
MASSACHUSETTS

Electrostatic spray room, showing disk

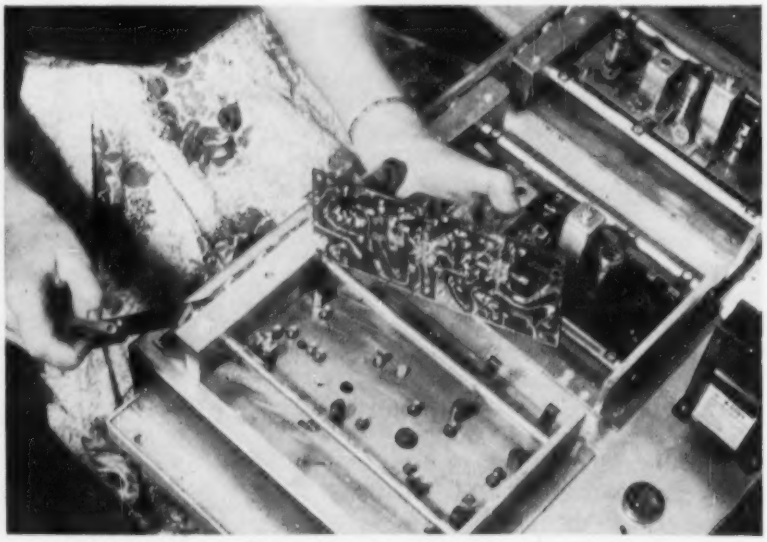
Matching wood and metal finishes

grounded cabinet shells serves to give an even coating over the entire outside surface of the shells.

▶**Shading**—After the wood front frame has been attached to the metal cabinet shell, final shading insures that the finish on the wood will match the simulated finish on the top and sides. This detailed spray painting operation is performed with a hand-held spray gun in a spray booth while the cabinets move past on a roller conveyor. The pallets used are large enough to hold two cabinets back-to-back. A large cog arrangement serves to turn the pallets automatically so that the painter can easily process both sides of the wood frame.

Gear-Operated Video I-F Alignment Setup

AFTER dip soldering, tv boards are tested and aligned in semi-automatic setups at RCA's Indianapolis and Bloomington plants. Three positions are usually provided, to give preheating time. The boards are placed over spring-loaded contacts positioned to meet with the desired terminals on the etched wiring. A lever is then used to actuate a train of four gears. These move spring holding fingers down over the board to press it against the contacts. When the board is in



Placing board on empty position while tubes are warming up preparatory to alignment at other two positions

UNITED ANNOUNCES NEW DC-6A CARGOLINERS

Five new DC-6A Cargoliners® are joining the United Air Lines fleet—increasing our all-cargo space by nearly 70%! Each of the new DC-6As carries up to 30,000 pounds of cargo, at 300 miles an hour. . . and accommodates single pieces up to 76" x 81" x 115", and up to 8000 pounds.

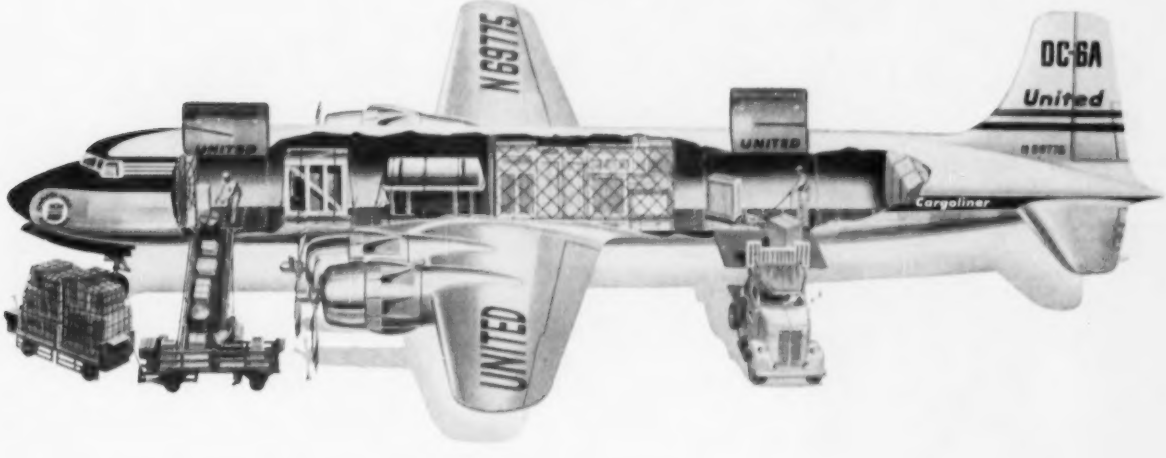
Each is equipped with radar, a United cargoplane "exclusive" for smoother flight and better on-time performance—plus many other improvements of special interest to shippers.

In addition, all of our regular passenger Mainliners® carry cargo to the 80 cities on our route. And only United offers you these extra services:

Telemeter Air Bill. Special new equipment and United's vast communications system makes possible the handling of complete air bills by wire. Advance notice of expected arrivals is possible while shipments are still in the air. This means the consignee can have pickup arrangements completed when the plane arrives. No "time out" for your shipment!

Reserved Air Freight Space. Space can be reserved on any United plane, or connecting world-wide carrier!

It all adds up to a completely new standard of air freight service for you!

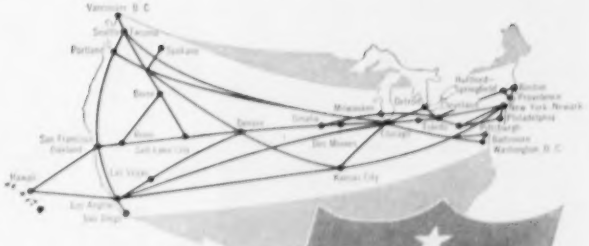


New, Exclusive Features for your benefit . . .

Tie-Down Strength Greater than any other airline. All rings in the main cabin between doors are 5,000-lb. Twelve 10,000-lb. rings. All metal floors.

Aluminum Pallets allow preloading, speed handling, protect cargo.

Motorized Tug Bar enables United to handle the heaviest pieces of any airline.



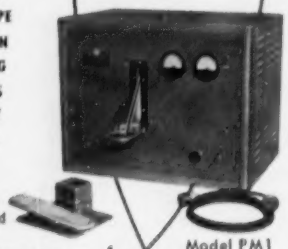
UNITED AIR LINES

For service or information, call or write the nearest United Air Lines Representative. Write for new booklet on air freight tailored to your needs! Cargo Sales Division, Dept. V-4, United Air Lines, 5959 S. Cicero Avenue, Chicago 38, Illinois.

marion
advancement in instrument design

SOLDERING PROBLEMS ?

PORTABLE BENCH-TYPE INDUCTION SOLDERING UNIT CUTS ASSEMBLY COSTS...



Simplifies, improves and speeds up component production. Provides local heat to otherwise inaccessible spots. Safe and simple. Max. power input 775 watts, 100 watts standby; 115 volts, 60 cycles. Measures 15¾" x 21½" x 12", weighs 150 lbs. Price $414.00, foot treadle extra. Complete data on request.

Model PM1

marion meters

marion electrical instrument company
GRENIER FIELD, New Hampshire's NEW Air-Industry Area
MANCHESTER, N. H., U. S. A.

Copyright © 1956 Marion

high-vacuum
high-voltage
rectifier tubes

DUNLEE

also a complete line of
industrial x-ray tubes

DUNLEE CORPORATION
4560 West Congress Street
CHICAGO 24, ILLINOIS

Want more information? Use post card on last page.

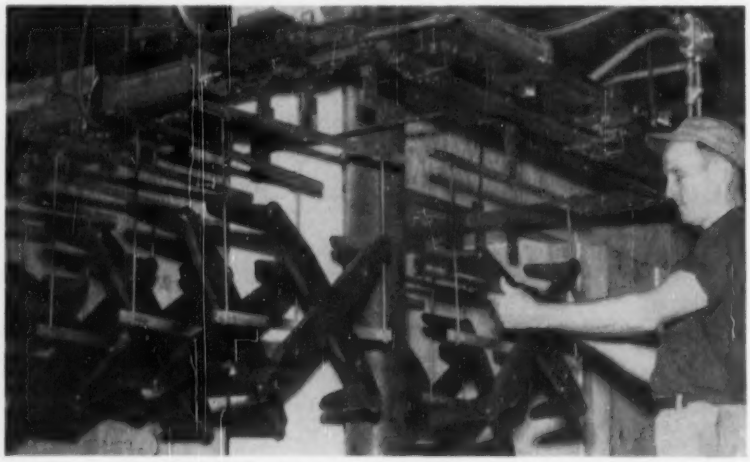
position it holds down the nylon button of a master switch that applies plate voltages to the circuits of the board.

Anvils support the board under transformers requiring adjustment, to prevent breakage of the board under pressure of the adjusting tool. Other chromium-plated anvils are located directly under the spring hold-down springs so as to give good ground connections for the etched wiring.

When adjustments must be made below a board, captive screwdrivers are mounted under the test bench.

Moving lever to rotate gear train that brings spring clips into position to push wiring board down over contacts

Square-Corner Conveyor Saves Floor Space



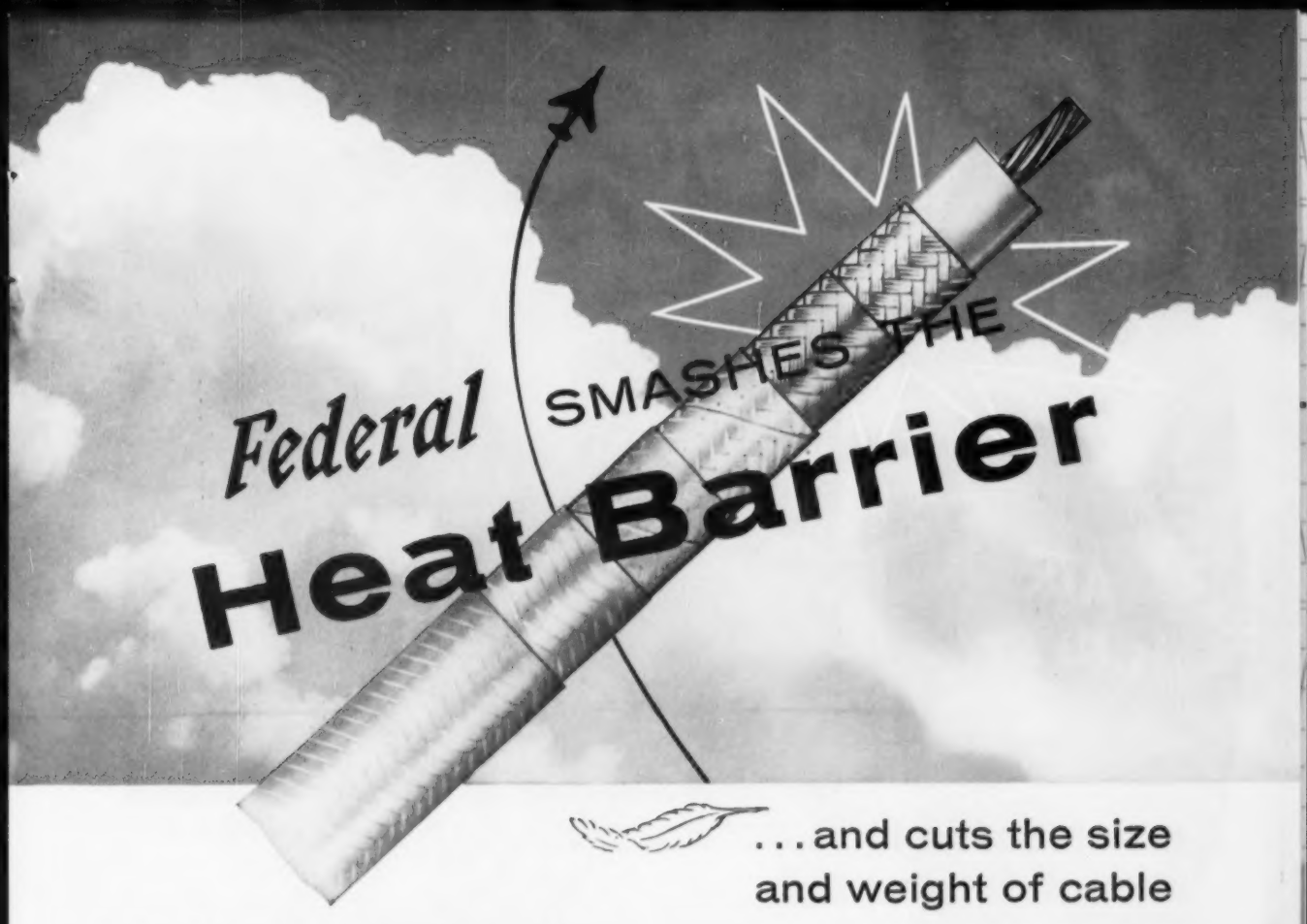
Square-corner conveyor transfer setup at output of drying tunnel for spray-finished bases

AFTER WOOD swivel-base sections for television receiver cabinets travel through a curing tunnel for drying of their finish coats, a hydraulically operated shifting device automatically transfers each carrier in turn transversely to a parallel conveyor running back to the input of the tunnel. Use of this square-corner conveyor technique saved 75 percent of the space that would otherwise be required for this operation at the G-E Rockford, Ill. television cabinet plant.

Air cylinders actuated by trip-lever valves make the transfer operation completely automatic. When a conveyor hanger reaches the end of the line, it trips the first air cylinder. This pushes the hanger onto the transverse track and moves it to the end of this short track. The hanger then trips the valve of the other cylinder, and this in turn pulls the hanger onto the long return conveyor line.

Solenoids Connect Etched Wiring Board

SOLENOIDS tripped by snap-action switches make all connections and apply all voltages automatically when an operator slides a sweep board into position at a special test and alignment setup in the Metuchen, N. J. television plant of Westinghouse Electric Corp. Interlocking switches insure that action cannot start until the board has



. . . and cuts the size and weight of cable

Federal's miniature coaxial cables—about ¼ the size of comparable RG types—save critical space and weight in aircraft and instrument uses.

Challenged by the high temperature and minimum weight requirements of jet aircraft and guided missiles, Federal has designed RG cables that perform perfectly at a blistering 500° F.! New Federal miniature coaxials have a top temperature rating of 150° C. . . . up to 200° C. with an impregnated fiber glass jacket!

The key to these new cable developments lies in advanced designs.

Based on utilization of "Teflon," this superior dielectric maintains its excellent low loss and high voltage characteristics through a temperature range of 500° F. to −100° F. "Teflon" has no measurable water absorption; it is chemically inert . . . unaffected by alkalies, acids, aromatic fuels, aromatic organic solvents, and highly corrosive aviation hydraulic fluids.

If your cable problems involve heat, space or weight, it will pay you to consider Federal's new "Teflon" insulated cables. For information, write Dept. D-913A

"TEFLON" HIGH TEMPERATURE CABLES

RG-87A/U 50 ohms; 69.5% V.P.; 29.5 mmfd/ft. Cap; 4,000 operating volts.

RG-140/U 75 ohms; 69.5% V.P.; 29.5 mmfd/ft. Cap; 1,700 operating volts.

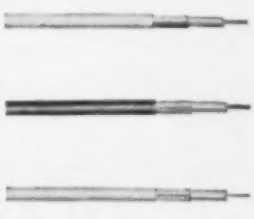
RG-141/U 50 ohms; 69.5% V.P.; 29.0 mmfd/ft. Cap; 1,500 operating volts.

"TEFLON" MINIATURE COAXIAL CABLES

K-256 50 ohms; 29 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 13 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/30 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-257 70 ohms; 21 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 14 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/34 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-258 93 ohms; 16 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 15 db/100 ft. Atten. at 400 mc; 7/38 silver-plated Copperweld conductor; 0.135 O.D. jacket.



"TEFLON" HOOK-UP WIRE—Type E, EE and FF Hook-Up Wires meet MIL-W-16878A. Available in all standard colors.

Federal

A DIVISION OF ITT

Federal Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

COMPONENTS DIVISION • 100 KINGSLAND ROAD • CLIFTON, N. J.

In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., New York

Want more information? Use post card on last page.

by every test

ATR
is BEST!
ATR
ATR
ATR
ATR AUTO RADIO
VIBRATORS
Have Ceramic Stack Spacers
A COMPLETE LINE OF VIBRATORS
Designed for Use in Standard Vibrator-Operated Auto Radio Receivers. Built with Precision Construction, featuring Ceramic Stack Spacers for Longer Lasting Life. Backed by more than 22 years of experience in Vibrator Design, Development, and Manufacturing.
Free
"A" Battery Eliminators, DC-AC Inverters, Auto Radio Vibrators
ATR
NEW MODELS
NEW DESIGNS
NEW LITERATURE
See your jobber or write factory
AMERICAN TELEVISION & RADIO CO.
Quality Products Since 1931
SAINT PAUL 1, MINNESOTA—U. S. A.
Want more information? Use post card on last page.

Adjusting transformer on sync board. All connections are made automatically by solenoids after operator slides board into position on test stand

been pushed all the way in between the two aluminum slides. Solenoids on opposite ends of the board then operate to lock the board rigidly in position, after which other solenoids bring a bank of spring-loaded contacts up against the bottom of the board and apply operating voltages. The operator can then proceed with test and alignment, using the automatically connected scopes as indicators.

Take-Apart Spools for Magnetic Telemetering Tape

By W. D. ISBELL
Flight Test Engineer
Convair (San Diego)
A Division of General Dynamics Corp.

New take-apart spool, at left, being disassembled from airborne tape recorder. Extra sleeve appears in center foreground. Spool at right is older solid type that cannot be taken apart

FLIGHT test programs for planes like Convair's new delta-wing supersonic interceptor involve handling of a tremendous volume of magnetic tape for airborne recorders. In this instance, the tape was used at Edwards Air Force Base Test Center in the arid Mojave wastelands near Muroc, California, then shipped to the data-reducing facility at San Diego.

▶ **The Problems** — Extremely low humidity, which makes magnetic tape brittle, prevented quantity storage of tape at the test center. The San Diego Division was shipping the tape on recorder spools as needed, but damage to spools and tape in shipping was proving costly because the spools are not repairable and valuable

1800 HEART BEATS

EVERY SECOND

without A MISS*

Every signal, in a telemetering system, passes through the commutation switch — truly the heart of the system.

To provide superior operating characteristics at this focal point, Mycalex Electronics Corporation developed Mycalex Model TM-55 Series Commutation Switches using SUPRAMICA® 555 ceramoplastic commutator plates.

Test results showed unquestionable superiority:
5500 hours at 600 RPM,
with only a simple brush cleaning
170 hours **continuous** operation at 1800 RPM
. . . and still functioning perfectly with a clean, unchanging signal!

SUPRAMICA 555 ceramoplastic is precision-molded in a wide variety of shapes and sizes offering: absolute dimensional stability—zero moisture absorption — dependable operation at temperatures as high as 950°F. — precise tolerance control — high dielectric strength — contacts cannot loosen even at widely different operating temperatures.

For information on Mycalex Model TM-55 Series Commutation Switches, MYCALEX® glass-bonded mica, and SUPRAMICA® ceramoplastics, write to General Offices and Plant, Box 311, Clifton, New Jersey.

*600 RPM Operation

MYCALEX ELECTRONICS CORPORATION *EXECUTIVE OFFICES:*
30 ROCKEFELLER PLAZA NEW YORK 30, NEW YORK

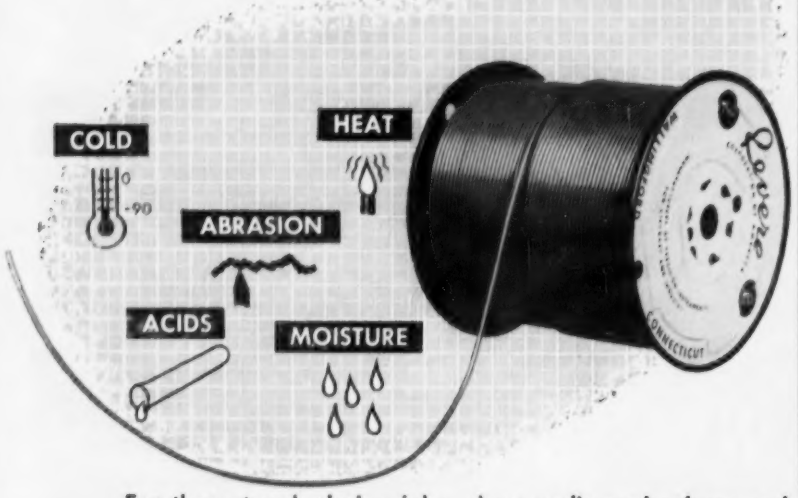
UNDER EXCLUSIVE LICENSE OF THE MYCALEX CORPORATION OF AMERICA

SINCE 1919 MYCALEX THE INSULATOR

WORLD'S LARGEST MANUFACTURER OF GLASS-BONDED MICA AND CERAMOPLASTIC PRODUCTS

Los Angeles Office:
Mycalex Corporation of America, 5657 Wilshire Boulevard, Los Angeles, California, WEbster 8-2169
Chicago Office:
Mycalex Corporation of America, 6677 Northwest Highway, Chicago 31, Illinois, NEwcastle 1-7062
Minneapolis Office:
Mycalex Corporation of America, 8th St., Minneapolis, Minnesota, Fillmore 7701
Washington Office:
Mycalex Corporation of America, 1411 Pennsylvania Avenue NW, Wash. 4, D. C., REpublic 7-7040

Insure Product Performance...
REVERE SPECIALTY WIRES



For those tough design jobs where ordinary hook-up and thermocouple wires die from the heat, get brittle in cold, abrade and corrode . . . Revere SPECIALTY wires stand up. Built to MIL and customer specifications, Revere's wide range includes:

HOOK-UP WIRES

For High Temperatures

REVCOTHENE—(Extruded Monochlorotrifluoroethylene) —40°F to +275°F, AWG 28 to 10, silver plated copper conductors, inert, excellent dielectric strength, no volatile plasticizers, non-flammable, thin wall, abrasion and moisture resistant.

For Extremely High Temperatures

Fiber glass (to 700°F), asbestos (to 900°F), pure silica glass fiber (to 1500°F) wrapped or carded with outer braid and saturant as required by application.

MULTI-CONDUCTOR CABLES

A variety of telemetering and other multi-conductor cables constructed to customer specifications. Polyethylene, polyvinyl, nylon, glass, Revcothene, asbestos insulations for singles and jackets. Twisting, braiding, shielding, color coding to suit conditions.

THERMO-COUPLE WIRES

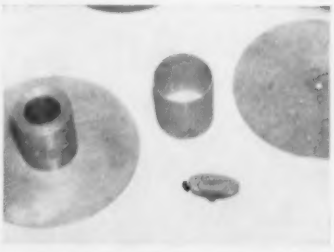
Iron-constantan, copper-constantan, Chromel-Alumel conductors, AWG 36 to 14, various insulation combinations and protective braids, temperature range from —100°F to +1500°F, constructed to rigid tolerances.

Saturants for flame and abrasion resistance, metallic braids for severe service and electrical shielding. Color coding in fourteen solid colors and stripes.

Prompt delivery of standard stock wires. Write for samples and literature on specialty hook-up or thermocouple wire.

Revere CORPORATION OF AMERICA 20

WALLINGFORD, CONNECTICUT A Subsidiary of Neptune Meter Company



Components of 5-inch take-apart spool

Components of 10½-inch spool

test data was often being lost.

To further complicate the processing, it soon became evident that the space needed to store the spools and used tape after data reduction would assume staggering proportions. It takes approximately 80 spools of tape to service one recorder for six months. Another problem involved the cost of spools which could be used only once and then stored for an indefinite period. The spools range in price from $20 for the 5-inch reel to $35 for the 10½-inch size.

► **The Answer** — A satisfactory solution to these problems was achieved by designing and building take-apart spools that could be used over and over again. These new spools incorporated sleeves upon which the tape is wound, so that the tape-loaded sleeve can later be removed and stored.

Cans formerly used for the ship-

Components of shipping container assembly for 5-inch reels. Pads of rubberized hair hold tape snug

now in production...
and available for immediate delivery!
the MODEL B 611 DATRAC

DATRAC
by EPSCO

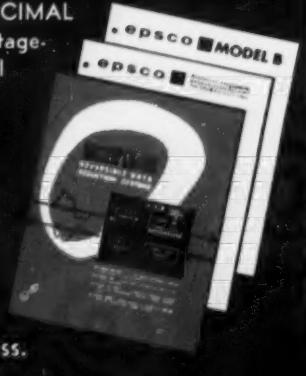
Reversible voltage-to-digital converter makes a complete, independent voltage-to-digital conversion every 22 microseconds or a complete digital-to-voltage conversion every 2 microseconds!

Now EPSCO, Incorporated, the leader in precision high-speed data reduction has available, as a shelf item, the Model B 611 Datrac Converter featuring ultra-high-speed and accuracy without manual calibration or adjustment of any type! Conservative design and total absence of mechanical switching assures reliable field operation.

ALSO AVAILABLE: THE BINARY CODED DECIMAL MODEL B 613 DATRAC CONVERTER having voltage-to-digital conversion time of 26 microseconds; all other specifications remain the same.

FEATURES:

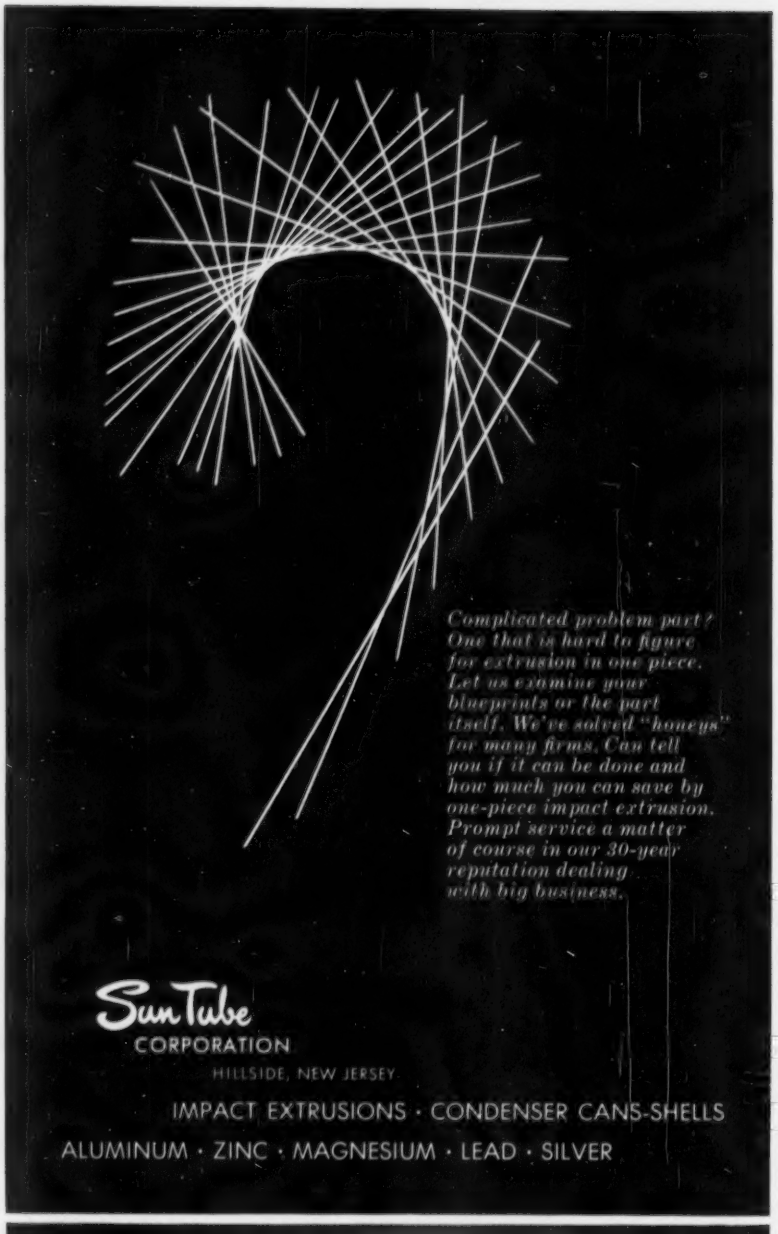
1. Voltage-to-digital conversion time:	22 microseconds
2. Digital-to-voltage conversion time:	2 microseconds
3. Maximum full scale input voltage:	± 1,000 volts
4. Minimum full scale input voltage:	± 10mv
5. Data code:	Binary
6. Accuracy:	± .05% full scale ± ½ least significant digit
7. Calibration:	Automatic to an internal standard cell reference
8. Data Code Output Forms:	a. Serial pulse train b. Parallel semi-static binary valued voltage lines c. Positive parallel-line trigger pulses
9. Size:	19 inches wide by 26¼" high relay rack mounting (also available with cabinet as shown)



GET THE FACTS: Send for your copy of the detailed specifications and applications notes on the EPSCO high-speed DATRAC Series B Converters.

EPSCO INCORPORATED

588 Commonwealth Ave., Boston 15, Mass.


Complicated problem part? One that is hard to figure for extrusion in one piece. Let us examine your blueprints or the part itself. We've solved "honeys" for many firms. Can tell you if it can be done and how much you can save by one-piece impact extrusion. Prompt service a matter of course in our 30-year reputation dealing with big business.
SunTube
CORPORATION
HILLSIDE, NEW JERSEY
IMPACT EXTRUSIONS · CONDENSER CANS-SHELLS
ALUMINUM · ZINC · MAGNESIUM · LEAD · SILVER

Shipping container ready for shipment to data reduction station, with identifying data marked on side with grease pencil

ment of instruments were found to be ideal for conversion to tape shipping containers. The tape is first transferred from the manufacturer's large supply spools to one of the take-apart spools. The spool is then disassembled and the tape removed with its sleeve and placed in the container. Each container will hold three of the 5-inch rolls of tape. The can is then sealed at San Diego, which boasts an ideal humidity, and shipped to Edwards.

Upon receipt of the tape, ground crews at Edwards can rearm the planes' recorders without removing the take-apart spools from the aircraft. After a flight the tape is removed and returned to the San Diego data-reducing station.

The new spools as built by Convair cost about three times that of standard production reels, but it now takes only two spools to service one recorder indefinitely. The spools are fabricated from 75 ST aluminum. The sleeves, on which the tape is transported, can be made of any nonmagnetic rigid material such as aluminum, Micarta or molded plastic.

Plug-Assembly Conveyor

PLUG and wire assemblies for aircraft electronic systems are now made at Martin on an assembly-line conveyor. The first wire of an assembly is identified, cut to length on

Large, easy to read permanent records—over 8 cm excursion.

Speed plus sensitivity—15 microvolts d-c per millimeter—1/120th second deflection time.

Completely stable—has absolute zero base line drift.

No hysteresis—high-torque returns stylus to base line—even with paper stationary.

TAKE A LOOK AT A 20 YEAR RECORD!

OFFNER DYNOGRAPH RECORDERS

Offner Dynograph Recorders are the result of 20 years of development and production experience. Originally used in the electro-medical field where high speed and sensitivity to minute signals were imperative, industrial models of the Dynograph *have established many new performance standards for direct-writing oscillograph recorders.*

Compare the Offner Dynograph with all other direct-writing oscillographs on the market today—if you do, you'll choose the Dynograph.

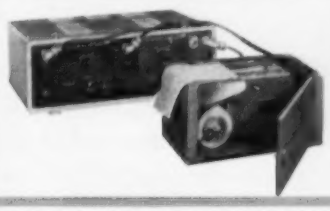
High sensitivity—up to 15 microvolts per mm.
Stability—absolutely drift-free
No "warmup"—immediately stable and ready to use
One percent linearity—for 5 centimeters deflection
One amplifier—for all recording applications
Large, easy to read and easy to measure records
Rapid pen response—1/120th second deflection time

If you want the widest versatility, highest accuracy, and greatest reliability in direct writing high speed oscillographs—select the Offner Dynograph! It's the result of 20 years of development and production experience.

Write for your copy of the Dynograph Bulletin; get complete details and application information. Our Engineering Representative in your area will demonstrate the Dynograph in your plant—write for a demonstration date.

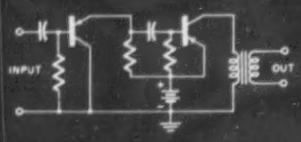
Type MC Console. *Specially designed for computor write out, telemetering, and other low gain applications.*

Type M Console. *Accommodates up to six recording channels with specialized input couplers, for a wide variety of applications—eight chart speeds, 1 to 250 mm. per second.*



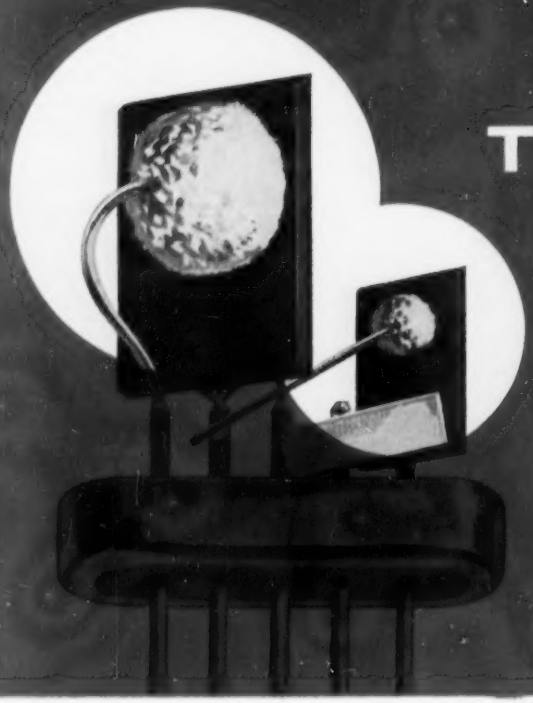
Type P Portable Dynograph. *Single and Dual Channel Units—performance specifications identical to those of the console model—Chart speeds from 1 to 100 mm. per second.*

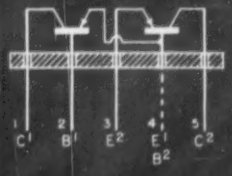
OFFNER ELECTRONICS INC.
5324 N. Kedzie Avenue, Chicago 25, U.S.A.



NOW from **MARVELCO** laboratories . . .

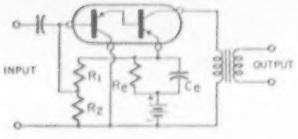
TANDEM TRANSISTORS!





The outstanding development

in the field of semi-conductor devices



Housed in a single case, two dc-coupled transistors now open an entirely new field for the mighty midgets of electronics as oscillators, multivibrators, flip-flops, switching devices, etc.!

A common-collector transistor stage acts as the input device of a second transistor to serve as a useful type of dc matching transformer. No extra power supply is required since the first transistor represents the base leak for its successor.

Now available in limited quantities for laboratories and research.

For complete details on the MT-1 Tandem Transistor write or wire:

MARVELCO *Electronics Division*
NATIONAL AIRCRAFT CORPORATION
3411 Tulare Avenue, Burbank, California

MARVELCO

In addition to the tandem transistor described on the preceding page MARVELCO also produces the following transistors available for immediate delivery in commercial quantities:

TYPE "J"
Audio Frequency Junction Transistor
The Type "J" is designed for use in medium gain, low-to-medium power applications at audio or ultrasonic frequencies.

TYPE "IF"
Intermediate Frequency Junction Transistor
Available for the first time is a transistor designed for switching speeds and still preserving high collector dissipation. For use in medium gain, low-to-medium power application at ultrasonic frequencies.

TYPE "HF"
High Frequency Junction Transistor
Type "HF" is designed for use in medium gain, low-to-medium power applications in the high frequency spectrum.

TYPE "JP-1"
Power Transistor
Designed for use in medium gain, intermediate power amplifier and switching applications. For maximum efficiency in push-pull operation, matched pairs may be ordered at no additional cost.

TYPE "RF-1"
Junction Type High Frequency "Ham" Transistor
Designed for use in medium gain, low-to-medium power applications in the high frequency spectrum.

TYPE "CQ-1"
Junction Type "Ham" Transistor
Designed for use in medium gain, low-to-medium power amateur applications at audio and ultrasonic frequencies.

MARVELCO TRANSISTOR SOCKETS
Socket permits ready interchange of transistors and precludes damage to transistor by soldering unit into a circuit. Designed for group mounting permitting space conservation when a large number of transistors are to be mounted in final assemblies such as computer circuitry. Also has high degree of utility in R&D bench work stage of circuit design.

TYPE HS
High speed switching transistors having very rapid rise and power time characteristics. These units combine high peak current capability and low saturation potential drop. For use in computer and flip-flop application.

For complete specification data write to

MARVELCO Electronics Division
NATIONAL AIRCRAFT CORPORATION
3411 Tulare Avenue • Burbank, Calif.

Want more information? Use post card on last page.

Conveyor runs at rear of long, narrow assembly bench for aircraft electronic cables and plugs

a semiautomatic machine and put on the conveyor belt with the plugs and fittings. It travels to the next worker who removes a portion of the nylon jacket and adds Vartex identification sleeves. Part of the braided shield around the wire is made into a pigtail for a subsequent ground connection. One end is then stripped, tinned and soldered to the pretinned plug terminal. Other wires belonging to the assemblies are prepared singly and placed upon the conveyor, going in sequence to the workers who solder them to the plugs.

The braided shield pigtails are soldered to a common grounding ring. Vartex identification sleeves are tied temporarily in place and the assembly is visually inspected. The wires are bundle-laced at intervals and the assembly is tested electrically before potting. In the final operation, the Vartex identification sleeves are adjusted to suit contract requirements and the wire assembly is ready for installation. As many as sixty plugs can be assembled simultaneously on this belt-conveyor.

Etched Wiring Boards Have Resistivity Problem

By L. J. MARTIN and M. J. VAVRA
Weapon Systems Development Laboratories
Hughes Aircraft Co.
Culver City, Calif.

A WIDE range of resistivities has been observed in preliminary tests of laminates for etched wiring boards, as shown in Fig. 1. Among the phenolics, one showed lower resistivity when dry than three others showed after three days at 98-percent relative humidity. The best material, when dry, had resistivities above 10^{15} ohms per square for all four samples, but its resistivity dropped by five orders of magnitude following humidity

Negative temperature and voltage coefficients

S.S.White 80X MOLDED RESISTORS

RATING — 3 watts — 100 to 100,000 megohms

SERVICE — High voltage equipment such as electrostatic generators, atomic energy equipment, etc.

CHARACTERISTICS

— Negative temperature coefficients
— Negative voltage coefficients
— Good stability, durability, mechanical strength
— Non-deterioration of values due to age
— Non-hygroscopic base specially processed against humidity
— Compactness

BULLETIN 4906 has full details. Send for a copy. Attention Dept. R.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO. 10 East 40th St. New York 16, N.Y.
Western Office: 1539 West Pico Blvd., Los Angeles 6, Calif.

Want more information? Use post card on last page.

irish BRAND **INSTRUMENTATION TAPE**

made by Orradio Industries, world's largest exclusive magnetic tape manufacturer—already ranks high in the esteem of automation engineers. Several of the leading makers of electronic computers, telemetering equipment and other devices requiring magnetic instrumentation tape have tested it, use it in volume and are recommending it to their customers.

But **irish**, never satisfied with just the status quo, would like to go further. Custom-engineered instrumentation tape, with electrical and physical characteristics tailor-made to *your* instrument, can be yours for the asking. **irish** would welcome the opportunity to come into your laboratory, discuss with you your individual requirements as to frequency response, hardness of coating, lubrication, drop-out tolerance, durability and other performance factors, and come up with the tape that *specifically* fits your needs to the minutest detail. *You* know best when it comes to your own instrument... **irish** knows best when it comes to magnetic tape . . . so get together with an **irish** application engineer—write, phone or wire **irish** today!

INDUSTRIAL DIVISION
ORRADIO INDUSTRIES, INC.
OPELIKA, ALABAMA
World's largest exclusive magnetic tape manufacturer

Export Division: Morhan Exporting Corp., New York
Canada: Atlas Radio Corp., Ltd., Toronto, Ontario

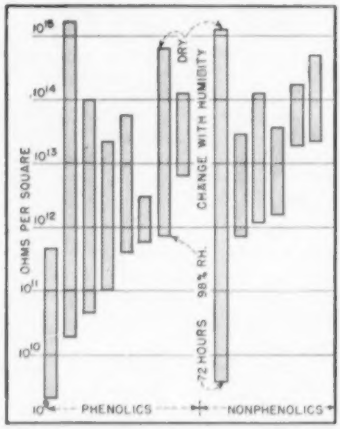


FIG. 1—Apparent surface resistivity of copper-clad plastic materials. Lengths of vertical bars represent change in resistivity; upper end of each bar is dry value and lower end is value after 72 hours at 98-percent humidity

exposure, at which time its resistivity was next to the lowest. The material which seemed next to the poorest in its dry state maintained its resistivity phenomenally after humidity exposure, showing the third highest wet resistivity. The best phenolic, according to these tests, showed 10^{14} ohms per square dry and nearly 10^{13} ohms per square when wet, a performance only slightly exceeded by two of the nonphenolics. One is forced to conclude that phenolics can be good or poor insulators and that their insulating properties shouldn't just be accepted on faith.

Turning to the nonphenolics, one manufacturer's glass-base silicone laminate showed the highest dry resistivity, above 10^{15}, but dropped well below 10^{10} after humidity exposure, a greater change than for any of the phenolics. The remaining nonphenolics included diallylphthalates, epon-glass, Teflon-glass and epon-orlon. Their resistivities were well clustered, with dry values similar to the better phenolics and generally with less deterioration of resistivity following humidity exposure.

Short-Run Cable Machine

A NEW planetary cabler, designed and built by Douglas Roesch, Inc., 2200 S. Figueroa St., Los Angeles, offers a solution to the problem of

• **Electrical Engineers**

New trends and developments in designing electrical products . . .

How General Electric Permanent Magnets help designers miniaturize products by supplying constant magnetic field energy in a fraction of the space required by electromagnets

WHERE constant magnetic field energy is necessary, powerful G-E Alnico permanent magnets offer the designer many advantages no electromagnet can match.

The most important of these advantages – from the designer's viewpoint – is the permanent magnet's superior volumetric efficiency. An Alnico permanent magnet can supply a given magnetic field in a fraction of the space required by even the best designed electromagnet.

Since miniaturization has become so vital in the electrical and electronics industries, it is important to see just why and how a permanent magnet utilizes space so much more effectively.

Figure 1 shows a typical magnetization curve of an electromagnet with a flux density of 20,000 gausses, when the polarizing force is 200 oersteds. (The curve has been displaced into the magnetizing quadrant for comparison purposes.)

In a well-designed electromagnet, approximately half the total area is occupied by conductors, and half is flux-conducting core material.

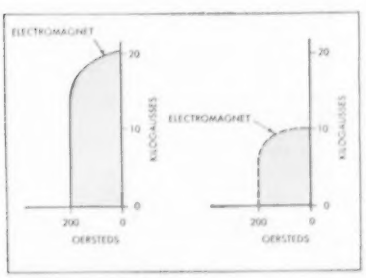


FIGURE 1

FIGURE 2

Therefore, to make the comparison valid, the residual induction of the electromagnet must be reduced to 10,000 gausses (Figure 2).

The area under the curve now represents the approximate external field energy available on a volume basis. When the equivalent demagnetization curve of Alnico 5 is plotted against the corrected electromagnet curve (Figure 3), the true capabilities of each type of magnet become immediately apparent.

The area under the Alnico 5 curve is about three times the area under the electromagnet curve. Thus, to produce a given field requirement, the permanent magnet will occupy a volume one-third that of an equivalent electromagnet.

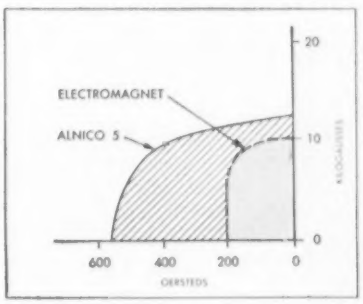


FIGURE 3

The above comparison is somewhat theoretical; under many circumstances, permanent magnets will show to even greater advantage. For example, consider the two TV-tube focusing magnets in Figure 4, at the top of the next column.

At the left, is the electromagnet previously used. It weighed 2 lbs. 13 ounces, and took up 16.35 cubic inches. At right, is the G-E Alnico 5 permanent magnet which replaced it. The new magnet weighs just 15 ounces, and occupies only 1.30 cubic inches – a space saving of 87%!

These savings in size and weight result from permanent magnets' inherent volumetric superiority. In addition, permanent magnets provide equally impressive savings in both initial and service costs because of four other inherent advantages.

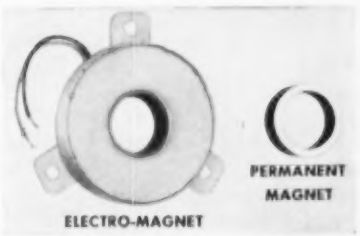


FIGURE 4

First, no power source is required with permanent magnets, because no energy is consumed. Once magnetized, the field is permanently retained.

Second, permanent magnets operate continuously. There can be no interruptions of the field due to power failure.

Third, permanent magnets are extremely stable under changing temperature conditions. They are unaffected by conditions ruinous to electromagnet installations.

Fourth, permanent magnet assemblies are easier to install, and cost nothing to maintain. There are no moving parts to break down, no wiring to burn out, no costly, time-consuming repairs to make.

These are but a few of the many reasons why designers are turning to G-E Alnico magnets for products for which only electromagnets had been previously considered.

If you have a problem where constant magnetic field energy is required, one of the G-E Alnico compositions may well be your solution. For more design data or technical assistance from our magnet engineers, write: *Carboloy Department of General Electric Company, 11137 E. 8 Mile Street, Detroit 32, Michigan.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

MIT
LINCOLN
LABORATORY

- Electrical Engineers
- Physicists
- Mathematicians

SAGE *(semi-automatic ground environment)*

AEW *(air-borne early warning)*

WHIRLWIND COMPUTER

SOLID STATE

HEAVY RADARS

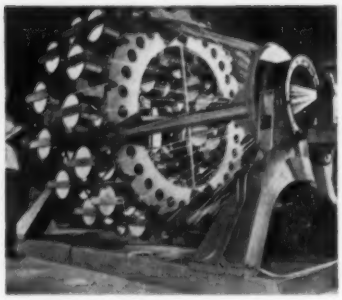
MEMORY DEVICES

SCATTER COMMUNICATIONS

TRANSISTORIZED DIGITAL COMPUTERS

If you are interested in participating in any of these programs address:

Dr. M. G. Holloway, Director
M.I.T. Lincoln Laboratory
Lexington 73, Mass.



Cable-maker for short-run orders can be easily changed over for producing wide variety of cables

supplying custom electronic cable in prototype or production runs. The new machine has successfully fabricated intricate multiple-conductor cables, delicate coaxial circuits, precision balanced quads and power leads into one manageable cable length. Quality can be compared favorably to mill-run, catalog power cable, despite the highly specialized nature of the short-run components.

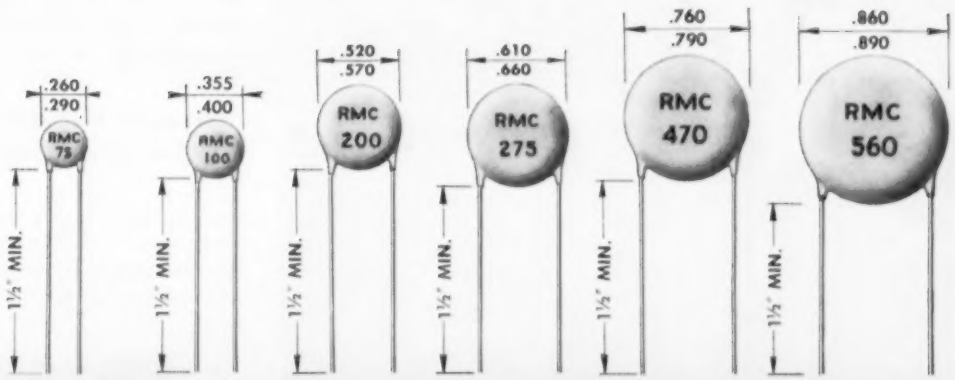
Mounting Wiring Boards on Color-TV Chassis

Two etched wiring boards used in RCA's new 26-tube color television receiver are both fastened to the chassis at one work position with the aid of an air gun and an efficient work handling arrangement in

Driving mounting screw into sound circuit board of color-tv set. The board already installed directly behind serves as the picture i-f section

The Complete Line of TC Capacitors

RMC DISCAPS



TC	1/4 Dia.	5/16 Dia.	1/2 Dia.	5/8 Dia.	3/4 Dia.	7/8 Dia.
P-100	1- 3 MMF	4- 9 MMF	10- 20 MMF			
NPO	2- 13	14- 29	30- 69	70- 85 MMF	86-115 MMF	116-150 MMF
N- 33	2- 13	14- 29	30- 56	57- 62	63-100	101-150
N- 75	2- 14	15- 27	28- 56	57- 68	69-110	111-150
N- 150	2- 15	16- 30	31- 68	69- 75	76-140	141-150
N- 220	3- 15	16- 30	31- 75	76- 90	91-130	131-190
N- 330	3- 15	16- 30	31- 75	76-100	101-150	151-190
N- 470	3- 20	21- 40	41- 80	81-120	121-200	201-240
N- 750	5- 29	30- 68	69-150	151-180	181-300	301-350
N-1500	15- 50	51-120	121-200	201-250	251-330	331-560
N-2200	47- 75	76-150	151-200	201-275	276-470	471-560

Temperature coefficients up to N-5200 available on special order.

SPECIFICATIONS

POWER FACTOR: Over 10 MMF less than .1% at 1 megacycle. Under 10 MMF less than .2% at 1 megacycle.

WORKING VOLTAGE: 1000 V.D.C.

TEST VOLTAGE (FLASH): 1750 V.D.C.

CODING: Capacity, tolerance and TC stamped on disc.

INSULATION: Durez phenolic-vacuum waxed.

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms.

AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms.

LEADS: No. 22 tinned copper (.026 dia.).

TOLERANCES: ±5% ±10% ±20%

These capacitors conform to the RTMA specification for Class 1 ceramic condensers.

The capacity of these condensers will not change under voltage.

Type C DISCAPS are available in a wide range of capacities and temperature coefficients and the millions used over the years prove them to be the ideal replacement for tubular ceramic and mica capacitors.

Their smaller size, greater stability, and greater mechanical strength are features that leading manufacturers of electrical and electronic products have found advantageous. Rated at 1000 working volts, Type C DISCAPS cost no more than ordinary 600 volt capacitors.

If your applications involve printed circuits, Type C DISCAPS are available with plug in leads.

DISCAP CERAMIC CAPACITORS

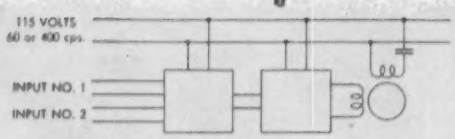
RMC

RADIO MATERIALS CORPORATION
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Want more information? Use post card on last page.

NEW!
MINIATURE
SERVO
Magnetic Amplifiers

Three New AC Servo Types Available..



STANDARDIZED SERVO SYSTEMS AND OTHER STANDARD TYPES FOR AUTOMATIC CONTROL —

In addition to new lines illustrated, many standard and higher power magnetic amplifiers are available for applications involving automatic control.

CUSTOM DESIGNS FOR SPECIAL REQUIREMENTS

— we design and engineer complete servo or automatic control systems

● MAGNETIC PRE-AMP + SATURABLE TRANSFORMERS
Supply: 115 volt 400 cps.
Power output: 3.5, 6, 10, 18 watts
Sensitivity: 1 volt AC
Response Time: .03 sec.
Lowest Cost — Smallest Size
For further information request Form S493

● MAGNETIC PRE-AMP + HIGH GAIN MAGNETIC AMPLIFIER
Supply: 115 volt 400 cps.
Power output: 5, 10, 15, 20 watts
Sensitivity: .1 volt AC
Response Time: .008 to .1 sec.
Highest performance — All magnetic
For further information request Form S496

● TRANSI-MAG*: TRANSISTOR + HIGH GAIN MAGNETIC AMPLIFIER
Supply: 115 volt 400 or 60 cps.
Power output: 2, 5, 10, 15, 20 watts
Sensitivity: .08 volt AC into 10,000 ohms
Response Time: .01 sec.
Fast response at high gain
For further information request Form S499 (400 cps.); Form S497 (60 cps.)
*TRADE NAME

AFFILIATE OF THE GENERAL CERAMICS CORPORATION

MAGNETIC AMPLIFIERS • INC
Telephone: CYpress 2-6610
632 TINTON AVE., NEW YORK 55, N. Y.

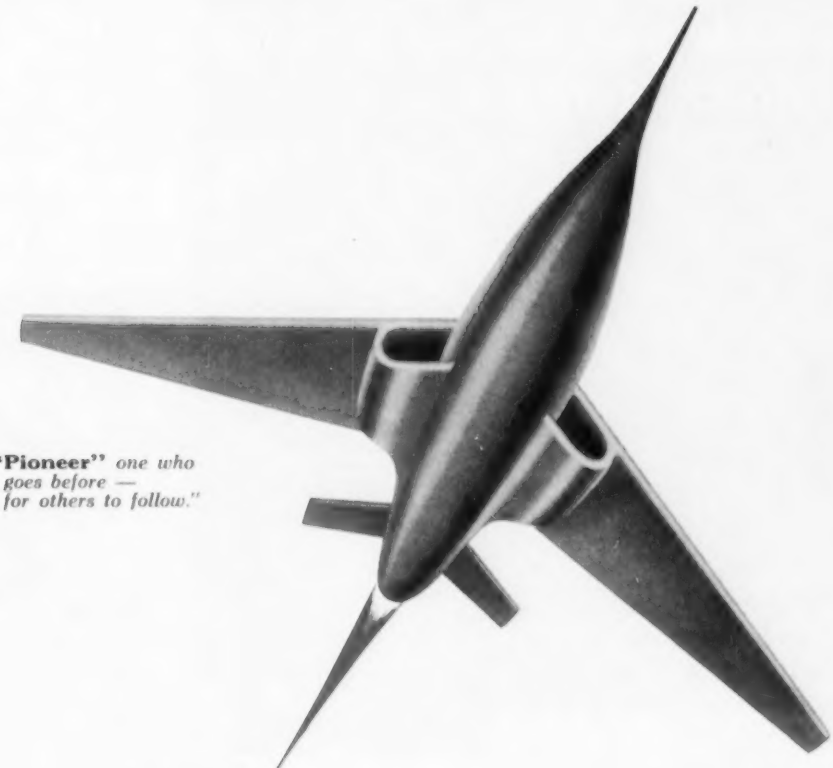
the firm's Bloomington, Ind. plant. The operator places each finished board in turn over its punched opening in the steel chassis, then anchors each board with six self-tapping screws taken from a bin directly in front of the bench. Each screw in turn is put into the magnetic chuck of the wrench, a washer is pushed over the screw, and the combination is driven through the previously punched holes in the wiring board and the chassis.

Changing Insertion Heads On Assembly Machine

QUICK changing of setups on the General Mills automatic assembly machine is achieved by using a standard housing at all stations and having a variety of inter-

Loosening one of the two bolts that hold the insertion head in its housing. Magazine feed turret, which fits over vertical shaft, is removed first

Removing insertion head



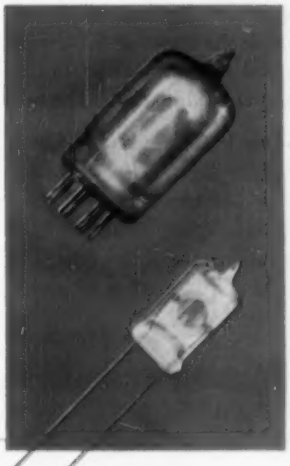
"Pioneer" *one who goes before — for others to follow."*

IF WEBSTER IS RIGHT —

Then Midland Has Done It Again, this time with

glass holders for crystals!

Permanent high vacuum attainable *only* with glass, isolates the crystal from atmospheric factors detrimental to dependable performance. Truly, here are crystals designed with the future in mind — future requirements of application and design as well as the long life of the unit far into the future.



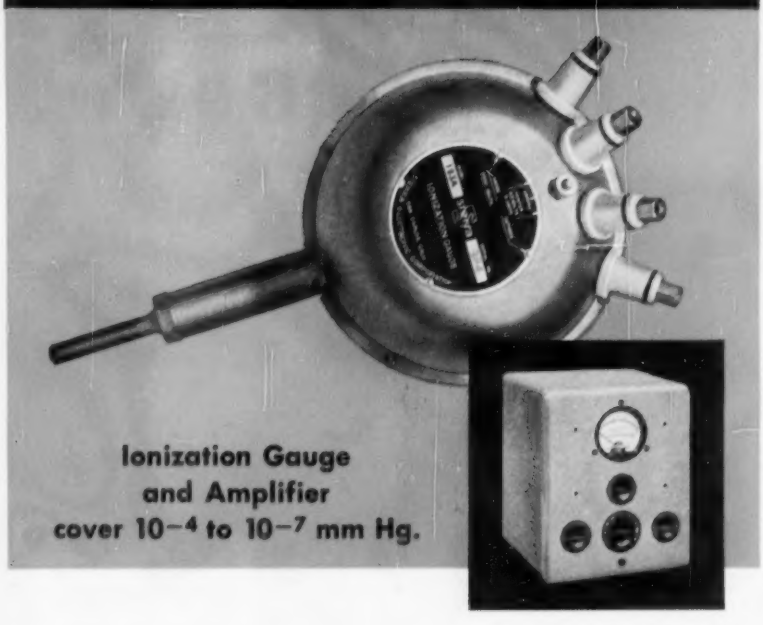
Midland MANUFACTURING COMPANY, INC.

3155 Fiberglas Road • Kansas City 15, Kansas

World's Largest Producer of Quartz Crystals

Want more information? Use post card on last page.

Dependable high vacuum pressure monitoring during processing!



New Model 193A Ionization Gauge and Model 192A Ionization Gauge Amplifier provide a convenient, accurate and dependable method of monitoring pressures from 10^{-4} to 10^{-7} mm Hg. The ion gauge can operate for months without attention; the cost and inconvenience of burned out gauges, poisoned cathodes, grid heating, etc., is eliminated.

Sierra 193A Ionization Gauge has a monel-encased interaction space with case near ground potential. A nichrome wire anode at 2.5 Kv is centered inside the case. An insulated out-gassing heater is mounted nearby. An insulated kovar tube is provided for connection to the vacuum line. Permanent magnets in the shell provide the magnetic field, with the shell serving as a return magnetic path, connection block, envelope and heater oven. Electrical connections are made to external binding posts. The tube weighs 22 oz., measures 7″ x 5″ x 3½″.

Sierra 192A Ionization Gauge Amplifier consists of a high voltage rf power supply, voltmeter, heater transformer and self-regulating low voltage power supply. It provides range switches, a special leak-check range for full scale meter deflection at any pressure, built-in calibrating circuits, and a heater switch for out-gassing the gauge tube. The instrument operates on 115 v 60 cycle power, measures 10″ x 8″ x 8″ and weighs 17½ lbs.

Specifications subject to change without notice

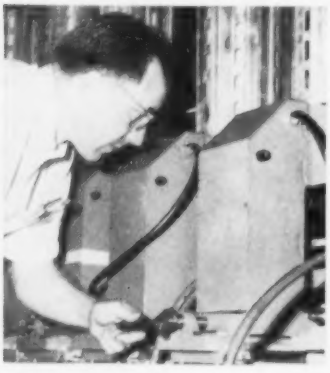
WRITE FOR COMPLETE DETAILS

sierra

Sierra Electronic Corporation
San Carlos 2, California, U. S. A.
Sales representatives in major cities
Manufacturers of Carrier Frequency Voltmeters, Directional Couplers, Wave Analyzers, Line Fault Analyzers, Wideband RF Transformers, Custom Radio Transmitters, VHF-UHF Detectors, Variable Impedance Wattmeters, Reflection Coefficient Meters, Calorimeters, Water Loads, Thermopiles, Ion Gauge and Ion Gauge Amplifiers, Phase Changers.
2665

changeable insertion mechanisms that fit into the housings of all stations. In addition, two simple wrench adjustments change the position of the entire housing at a station.

Two bolts anchor the head in its housing. When these are removed with a small Allen wrench, the 24-pound head can easily be lifted out by one man after disconnecting one air line and one cable connection. Actually, heads are changed in this manner only rarely because repositioning of standard heads is usually sufficient to accommodate a change in etched wiring boards.

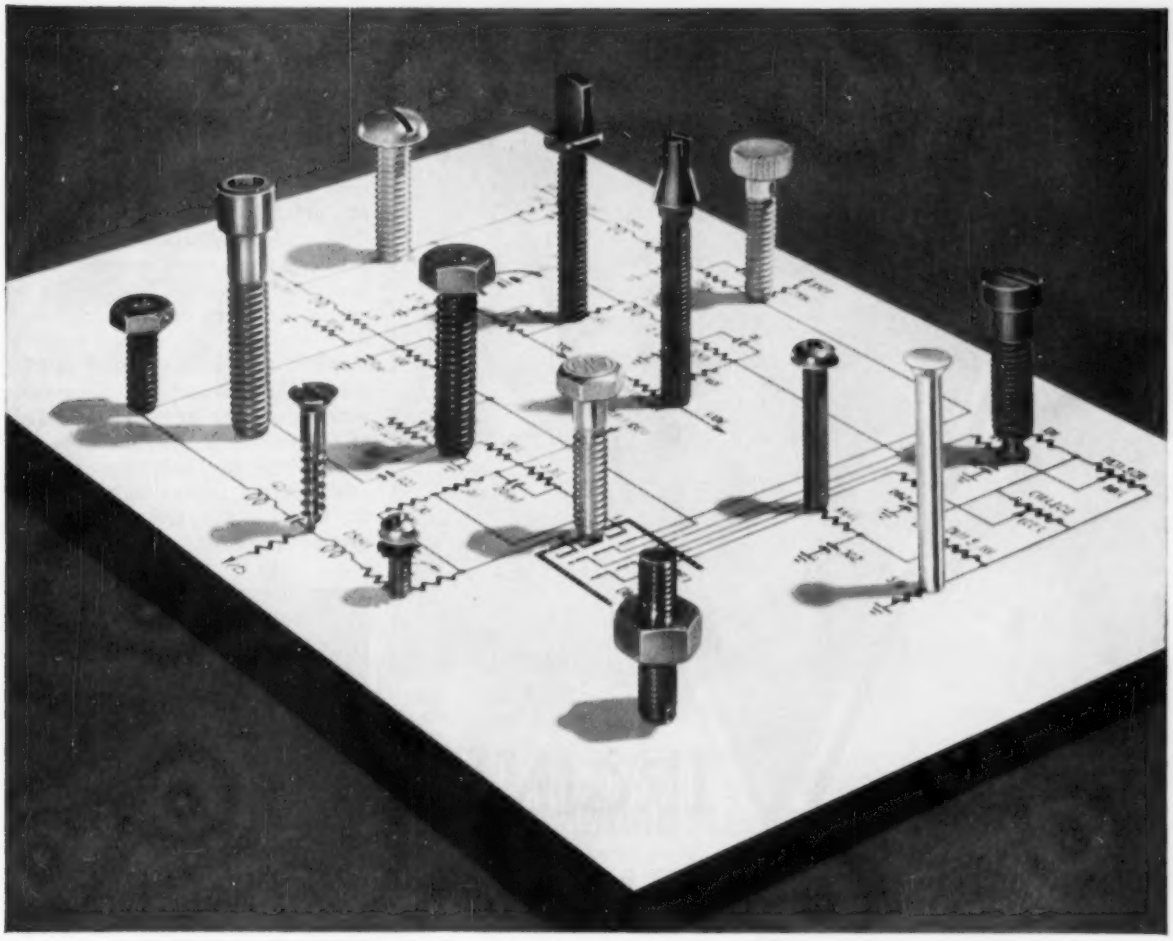


Method of repositioning insertion head laterally, after first loosening bolts of locking clamp just below transverse screw

Checking Linearity of Shaped Resistor Cards

RESISTANCE elements wound on shaped flat cards are checked for linearity and for shorted turns at taps with a special calibrating fixture in the Hicksville, N. Y. plant of Fairchild Controls Corp. A small and inexpensive cathode-ray

Linearity checking setup, with resistance card on fixture in front of B battery. Contact arm running over card is moved by stainless steel belt going over shaft of master potentiometer in front of operator



QUALITY PERFORMANCE

depends on small things

Manufacturers of electronic equipment recognize that such small things as fastenings are vitally important to the operation of that equipment...to the service that it gives...to the length of life that it serves.

Harper Everlasting Fastenings cost no more and you benefit by:

- The speed of assembly due to the clean threads and precision manufacture.
- The assurance of quality performance due to corrosion resistance and superior strength.
- The improvement in appearance due to the fact that Harper fastenings never rust.

More than 7000 different Harper fastening items are carried in stock in both non-ferrous and stainless steels. See your nearest Harper distributor or write for the Harper catalog.

THE H. M. HARPER COMPANY
8244 Lehigh Avenue, Morton Grove, Ill.

If you have a headed part that you are now milling from bar, it will pay you to investigate the Harper Flo-Form® method of producing such parts in quantities economically. Savings range up to 50%. Information on request from a Harper Field Engineer.

Specialists in all corrosion-resistant fastenings

Bolts • Nuts • Screws • Rivets • Washers
of Brass • Bronze • Monel • Aluminum • Stainless

OVER 7000 ITEMS IN STOCK...HARPER DISTRIBUTORS EVERYWHERE

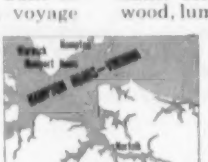
HARPER
Everlasting Fastenings

HE LAID THE KEEL OF TWO INDUSTRIES . . .

where deep-water shipping can serve your plant direct

SIR THOMAS ARGOLL wrote in 1613: "Went forward with my Frigat at Point Comfort, and finished her." She was the first big ship built in this country, and her first voyage was "for getting fish." Shipbuilding and fishing are still important to Virginia's Hampton Roads area, where a varied industrial output now totals $683,000,000 a year.

IF YOUR PLANT CAN PROFIT by a deepwater site, you will find the finest at Newport News, Norfolk, Portsmouth and South Norfolk. Over 300 ship lines link the harbor to 286 world ports, with sailings every 90 minutes. Three airlines, 9 major railroads and 45 truck lines serve this magnificent midway East Coast port and offer favorable rates to the Mid-west.



MANPOWER AND MATERIALS are abundant. Here, coal, chemicals, pulpwood, lumber, peanuts, soybeans and other raw materials roll up to your plant at short-haul cost.

AMPLE ELECTRICITY at low cost flows from VEPCO's modern power network. Its generating capacity expanded by 300,000 new kilowatts in 1955, with another 300,000 under construction and ready soon. For facts on taxes, zoning, water, natural gas, climate and other plus factors for your plant —or for confidential help in locating a suitable site, write or phone VEPCO, serving THE TOP OF THE SOUTH.

VIRGINIA ELECTRIC and POWER COMPANY

Clark P. Spellman, Director — Area Development
Electric Building, Richmond 9, Virginia • Phone: 3-4261

oscilloscope is used as an indicator for obtaining the high-precision check of calibration that is required for precision potentiometers.

For a test, the operator hooks the card over pegs on a holding fixture at the left of the calibrating wheel. One peg is rigid and is used for the card end from which measurements are made. The other holding peg is spring-loaded to keep the card under tension. A wiper contact mounted on a stainless steel belt is set to the start of the resistance winding and the large indicator dial of the master potentiometer is set to zero. The steel belt runs over the shaft of the master unit, so that the wiper on the card moves as the master is rotated.

Holding fixture for resistance card

After the card is located in the fixture and the leads are connected to the ends of the winding, a reference point of the particular function is selected to set up the checking equipment (scope, dial plate and master pot).

The master pot is set to the reference percent output (selected either by the customer or the manufacturer) by adjusting the vernier dial of the master potentiometer to the required value. The wiper is moved over the winding by rotating the dial plate until a null appears on the scope. The wiper is then locked in place and the dial plate is loosened to permit setting it at the desired angular location corresponding to the reference output. The dial plate is then locked in place and the wiper loosened, permitting it to traverse the winding again.

The linearity is then checked by rotating the dial plate to the angles specified on a function check sheet. The percent output corresponding to each angular setting is recorded from the master pot vernier after a null appears on the scope, for comparison with the theoretical percent output. The difference between

easy as . . .

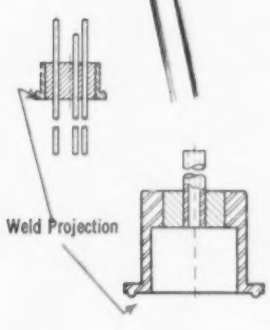
to assemble Hermetic Diode and Transistor Housings

These small, durably constructed units furnish the solution to assembly and procurement problems confronting design engineers and purchasing agents.

A variety of diode and transistor housings are available from Hermetic with weld projections and special metallic finishes to simplify assembly techniques. These units eliminate costly soldering steps—they result in man-hour savings!

The advanced design of Hermetic Transistor Housings provide additional advantages to the engineer and purchasing agent. The internally exposed areas of these parts are of all-glass construction. This construction feature prevents the contamination of a transistor wafer when closure is made after mounting and assures reliable transistor performance, as well as longer shelf life.

Practical designs . . . efficient production . . . technical assistance in the solution of procurement problems—this is just one phase of Hermetic's service to industry.



Write for complete data and catalogs. The film, "THE MANUFACTURE OF HERMETIC SEALS", is now available for company showings. Write for details.

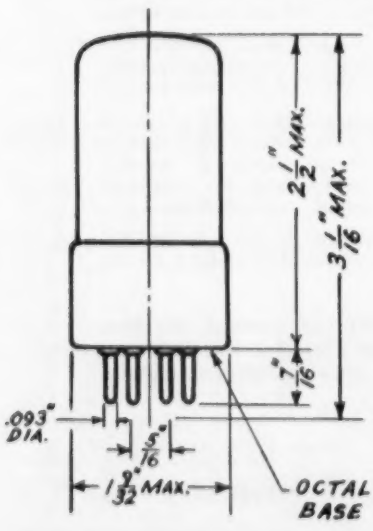
Hermetic Seal Products Company

31 South 6th Street, Newark 7, New Jersey

California Associate: Glass-Solder Engineering, Pasadena

SERVICE AND RELIABILITY ARE OUR MOST VALUED COMPONENTS

A *New* 1000 kc PRECISION CRYSTAL FOR FREQUENCY STANDARDS



This precision sealed-in-glass crystal unit provides exceptional stability with minimum ageing when used as a reference source in secondary frequency standards.

WRITE FOR BULLETIN #491

Bliley

BLILEY ELECTRIC COMPANY

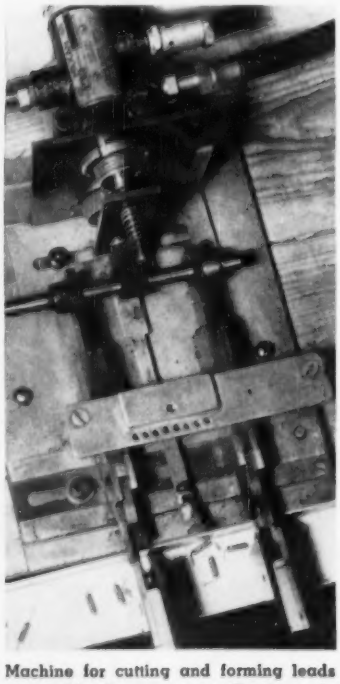
UNION STATION BUILDING - ERIE, PENNSYLVANIA

the actual and the theoretical is the error. The error must be within tolerance to pass inspection.

Cutting and Forming Leads

RESISTOR and capacitor leads are cut and formed by an air-actuated machine that can be fed by hand at rates up to 1,500 components per hour, in the Cambridge Radio Works of Pye Ltd. Once the air is turned on, the machine operates automatically, at a speed which can be set to suit the operator. Positions of the cutting and forming blades are continually adjustable to leave any desired length of wire on each lead. Adjustment is made by loosening Allen screws and sliding the entire cutting and forming members sideways.

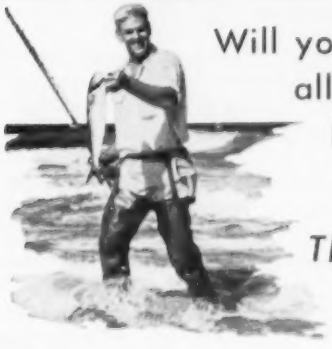
The operator grasps each component in turn by the end of one lead and holds it against a stop between the cutting jaws. After the leads have been cut and formed, the unit is dropped into the chute below. The chute is designed so it can



Machine for cutting and forming leads of axial-lead components. Continuously operating air cylinder at rear is made by The Climax Rock Drill & Eng. Works Ltd., Carn Brea, Cornwall, England

ENGINEERS...
LOOK TEN YEARS AHEAD!

A Douglas engineer lives here



Will your income and location allow you to live in a home like this...spend your leisure time like this?

They can...if you start your career now at Douglas!

Take that ten year ahead look. There's a fine career opportunity in the engineering field you like best waiting for you at Douglas.

And what about the Douglas Aircraft Company? It's the biggest, most successful, most stable unit in one of the fastest growing industries in the world. It has giant military contracts involving some of the most exciting projects ever conceived...yet its commercial business is greater than that of any other aviation company.

The Douglas Company's size and variety mean that you'll be in the work you like best—side by side with the men who have engineered the finest aircraft and missiles on the American scene today. And you'll have every prospect that ten years from now you'll be where you want to be career-wise, money-wise and location-wise.

For further information about opportunities with Douglas at Santa Monica, El Segundo and Long Beach, California and Tulsa, Oklahoma, write today to:

DOUGLAS AIRCRAFT COMPANY, INC.
C. C. LaVene, 3000 Ocean Park Blvd.
Santa Monica, California

DOUGLAS **First in Aviation**

Specially aged and ruggedized for high-performance applications

Bendix Red Bank

RELIABLE TUBES

FEATURING "LONG LIFE" CATHODE

The solid alumina oxide insulator, coiled heater, and sleeved heater legs combine to *eliminate* heater-cathode shorts and *reduce* heater-cathode leakage, thus providing unparalleled operating dependability.

TUBE TYPE						
Type	5838	5839	5852	5993	6106	6754
Prototype	6X5	6X5	6X5	6X4	5Y3	412A
Bendix No.	TE-3	TE-2	TE-5	TE-10	TE-22	TE-36
Class	Full Wave Rectifier	Full Wave Rectifier	Full Wave Rectifier	Full Wave Rectifier	Full Wave Rectifier	Full Wave Rectifier
Base and Bulb	Octal T-9	Octal T-9	Octal T-9	9-Pin Miniature	Octal T-9	9-Pin Miniature
TYPICAL OPERATING CONDITIONS						
Heater Voltage	12.6	26.5	6.3	6.3	5.0	6.3
Plate Volts Per Plate	350	350	350	350	350	350
mA Load	70	70	70	70	100	100

Type	5992	6385
Prototype	6V6	2C51, 5670
Bendix No.	TE-8	TE-21
Class	Beam Power Amplifier	Double Triode
Base and Bulb	Octal T-9	9-Pin Miniature
Heater Voltage	6.3	6.3
Plate Voltage	250	150
Screen Voltage	250	—
Grid Voltage	−12.5	−2.0
Gm	4000	5000
Plate Current	45mA	8mA
Power Output	3.5W	—

HARD GLASS TUBES

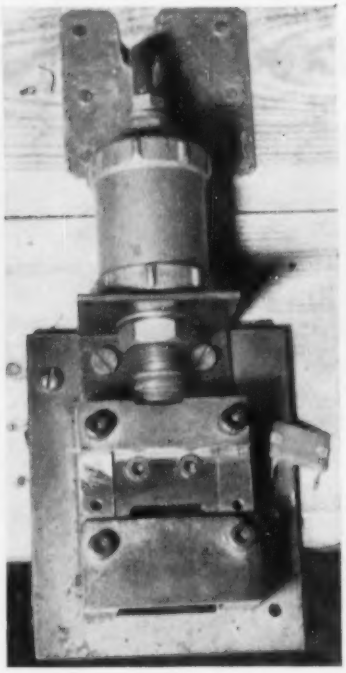
Type	6094	6384	6754
Prototype	6AQ5, 6005	6AR6	412A
Bendix No.	TE-18	TE-27	TE-36
Class	Beam Power Amplifier	Beam Power Amplifier	Full Wave Rectifier
Base and Bulb	9-Pin Miniature	Octal T-9	9-Pin Miniature
Heater Voltage	6.3	6.3	6.3
Heater Current	0.6 Amp.	1.2 Amp.	1.0 Amp.
Plate Voltage	250	250	350
Plate Current	45mA	77mA	—
Screen Voltage	250	250	—
Grid Voltage	−12.5	−22.5	—
Gm	4100	5400	—
Power Output	4.5W	8.5W	—
Load Current	—	—	100mA

The above three tubes incorporate hard glass bulbs for high-temperature operation (maximum bulb temperature 300°C).

Present-day military aircraft and missiles *require* electron tubes that are highly dependable under extremely severe operating conditions. *And building such tubes is our specialty.* Bendix Red Bank Reliable Tubes are rugged enough to withstand continuous vibration, varying voltages and frequent shock. For details on regular, or special-purpose, tubes to meet your specific needs, write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

West Coast Sales and Service:
117 E. Providencia Ave., Burbank, Calif.
Expert Sales and Service:
Bendix International Division,
205 East 42nd St., New York 17, N. Y.
Canadian Distributor:
Aviation Electric, Ltd., P. O. Box 6102, Montreal, Quebec.

Red Bank DIVISION — Bendix AVIATION CORPORATION



Air-actuated lead chopper for ceramic components

be lifted out when full and transferred to the assembly line for use as a dispenser bin.

Leads of ceramic disk capacitors and coupling plates are chopped to length by air-powered jaws under foot-valve control. This assembly is mounted on the front of the workbench, so that cut leads can drop into a bin below.

Components are inserted manually without clinching, with the aid of trolley cars that support wiring boards on a pass-along assembly line. The car is much like a chassis equipped with four rubber wheels, having in its top a framed rectangular hole to receive the wiring board. The trolley-car wheels run in semicircular channels cut into an ordinary wood-top bench. At each work station is a spring-loaded catch for holding the trolley while parts are being inserted in the wiring board.

After assembly is completed, the boards are removed for transfer to the dip soldering machine. The empty trolleys are placed on a sloping shelf at the back of the bench for gravity return to the start of the line.

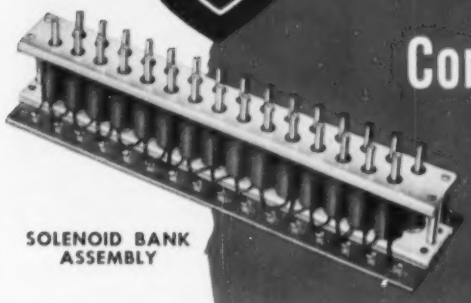
Component storage bins are open and mounted on a slant to give gravity feed. A protruding lip at

Specify GUARDIAN®

FOR Complete Control Assemblies

HOUSED – HARNESSED – CABLED

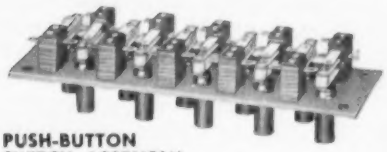
ready to plug in!



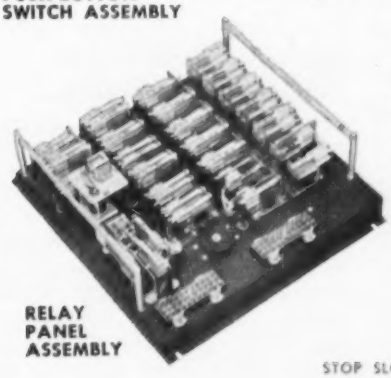
SOLENOID BANK ASSEMBLY

CONTROL BOX TESTER

SPECIAL "COMPUTIT" ASSEMBLY



PUSH-BUTTON SWITCH ASSEMBLY



RELAY PANEL ASSEMBLY

Units shown here typify the wide range of Complete Control Assemblies *designed, engineered* and *produced* by GUARDIAN. With absolutely dependable controls such as these, GUARDIAN engineers have solved seemingly insurmountable problems for both the military and commercial industry.

Let GUARDIAN'S 25 years of engineering experience help you save money, conserve space and prevent costly rejects. Whether you require relay banks, solenoid banks, control box testers, "Computit" assemblies, push-button switch systems—or an entirely different "package" control—Guardian has complete facilities to design and produce them.

STOP HIGH PRICES

STOP POOR QUALITY

STOP SLOW DELIVERY

STOP INEXPERIENCE

STOP POOR DESIGN

STOP REJECTS

GUARDIAN—for the ultimate in open, enclosed, sealed and hermetically sealed controls

GUARDIAN ELECTRIC

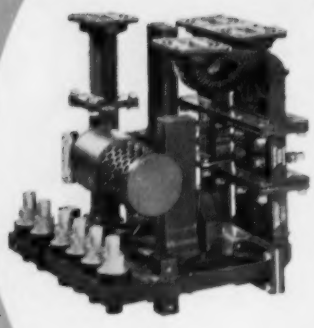
1625-D W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF CONTROLS SERVING AMERICAN INDUSTRY

Want more information? Use post card on last page.

TECHNICRAFT

for complex WAVEGUIDE assemblies like this



Compact packaging of this complex Mixer-Duplexer typifies results achieved with the combination of Technicraft-designed components, and Technicraft's manufacturing know-how.

MAKE

TECHNICRAFT

YOUR PRIMARY SOURCE

Designed with Precision

Built with Precision

Tested with Precision

One of our representatives is near you. Sales engineering offices in: Dallas · Dayton · Los Angeles Chicago · Seattle · St. Louis · Toronto (Canada).

SERVING RADAR AND COMMUNICATIONS WITH THE BEST IN MICROWAVE TRANSMISSION DEVICES

TECHNICRAFT LABORATORIES INCORPORATED

1550 THOMASTON RD. • THOMASTON, CONNECTICUT

Designers and Manufacturers of Rigid and Flexible Waveguide Assemblies, Microwave Test Plumbing and Components, Waveguide Systems.

Work station on trolley-car assembly line, showing open gravity-feed dispenser bins. Spring-loaded clip holds car steady as components are inserted in wiring board. Rubber wheels of car run in channels cut into wood bench

the bottom of each bin facilitates pickup. The lip of the bin is above the bench; a component is removed with the left hand by placing the thumb under the lip and the forefinger on top to draw a component to the edge and grab it.

Each component to be assembled is assigned a number in sequence. This is written on a tape tab placed on the lip of each dispenser bin. Corresponding numbers are screen-printed on the top of the wiring board, between lines going to the holes in which the particular component is to be inserted. This technique minimizes assembly errors and cuts down training time when starting up a line for a new design.

Intensity Markers Aid Television Alignment

By L. W. DIXON

Test Equipment Design
Radio Corporation of America
Television Division
Bloomington, Indiana

ALIGNMENT OF TELEVISION receivers on a production test line can often be made more efficient by the simultaneous presentation of negative and positive intensity markers to sweep signals being viewed on an oscilloscope. This is accomplished in the i-f section of chassis alignment by the use of a sweep generator feeding all i-f alignment positions on the production line. The sweep generator output is simultaneously fed into a sampling cir-

Want more information? Use post card on last page.

New Leesona No. 108 Coil Winders (foreground) in the plant of Ram Electronics, Inc., Irvington, N. Y., where Leesona Winders have become "standard equipment." These were added as best winders for producing short runs of stick-wound coils of varying specifications. (Inset) Ram has built an excellent reputation for winding quality coils and transformers used in radio and TV equipment.

RAM standardizes on Leesona coil winders...adds No. 108 machines

These winders help maintain highest quality standards . . . with good production performance

Ram Electronics, Inc. (Irvington, N. Y.) earned its fine reputation by adhering to unusually high quality standards.

This reputation, of course, is one they intend to keep. So in adding to coil winding facilities they picked Leesona No. 108 Coil Winders, standardizing on Leesona equipment which has served them so well in the past. To quote Mr. Del Vecchio, plant manager:

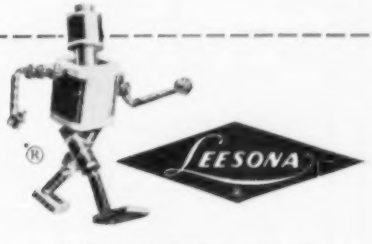
"We have come to count on Leesona Coil Winders to assure the high quality coils we insist upon for our products. That's why any additions to our present installation will be Leesona winders."

The Leesona No. 108 Hand Feed Coil Winder was designed specifically for complete accuracy, great flexibility and top production at low operating cost.

Investigate

how Leesona No. 108 Coil Winders can perform with great efficiency in your plant. The coupon will bring you complete details, together with other helpful coil winding information. Why not check and mail it today?

23B-5-6



FOR WINDING COILS IN QUANTITY... ACCURATELY...USE LEESONA WINDING MACHINES

UNIVERSAL WINDING COMPANY

P. O. BOX 1605, PROVIDENCE 1, RHODE ISLAND, Dept. 124

Please send me

- ☐ Bulletin on the Leesona No. 108 Hand-Feed Coil Winder.
- ☐ Condensed catalog of Leesona Winders.
- ☐ Bulletin on the new Leesona *Pay-As-You-Profit Plans* for purchasing or leasing modern coil winding machinery.

Name.....*Title*.....

Company.....

City.....*Zone*....*State*.....

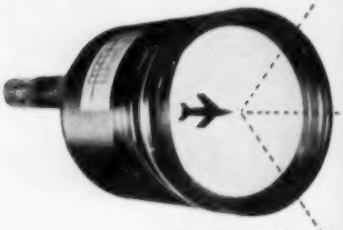
Want more information? Use post card on last page.

Farnsworth

IATRON

THE TUBE WITH SUN-LIKE BRILLIANCE

Here's the storage tube bright enough for direct viewing in a sun-lit cockpit . . . by several persons in a normally lighted room or a projection display of four feet! With one control knob, operator can set display for any persistence desired . . . from a few thousandths of a second to several minutes. All information can be erased instantly by merely pressing a button!



BIG DISPLAY PROJECTION

OPERATOR CONTROLLED VARIABLE PERSISTENCE

Another Farnsworth achievement . . .

One of many complex electronic products developed, designed, *and produced* for defense and industry . . . backed by over a quarter of a century of continuous success and leadership in the field of electronics.

Farnsworth

A DIVISION OF IT&T

for complete details on the IATRON storage tube, write

FARNSWORTH ELECTRONICS COMPANY · *FORT WAYNE, INDIANA*

a division of International Telephone and Telegraph Corporation

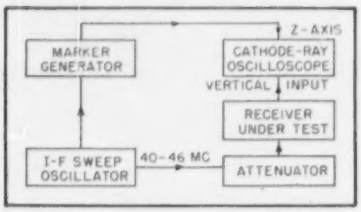


FIG. 1—Sweep generator and marker generator connections to equipment

cut containing crystals which become resonant as their frequencies are swept through, as in Fig. 1.

▶ **Method of Use** — Rectification and amplification of the output from the crystals results in pulses which are fed through a common cable to the Z axis of the oscilloscope for intensity modulation purposes. Positive pulses, appearing as bright dots on the i-f response curve displayed on the oscilloscope, are used to identify the frequencies used for peaking the i-f stagger-tuned stages, as in Fig. 2A and 2B. Negative pulses, identified by blanked portions of the trace as in Fig. 2C, are used as curve reference markers.

In operation the aligner feeds the i-f sweep signal into the chassis, peaks each stagger-tuned stage for maximum rise from the base line of the corresponding bright dot, then touches up the alignment by referring to the negative-blanked curve positions to obtain the proper position of the reference markers.

▶ **Advantages**—When master signal systems are used, this method has many advantages. The aligner

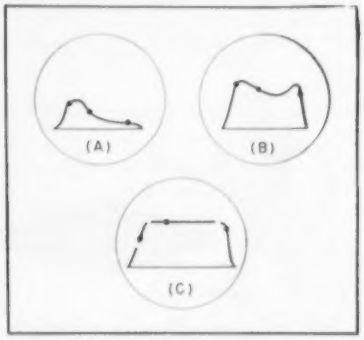


Fig. 2—Positive pulses as they appear before alignment (A), curve shape after positive pulse peaking (B) and i-f response after touchup (C) using negative pulses as reference markers

The "Blue Ribbon", resistor with a higher wattage rating per unit space requirement. Made by Hardwick, Hindle, Inc., Newark, N. J.

because of DRIVER-HARRIS 146 ALLOY

Here is a resistor really new and different . . . the compact Hardwick, Hindle "Blue Ribbon," which stands remarkably high overloads and excessive heat without crazing.

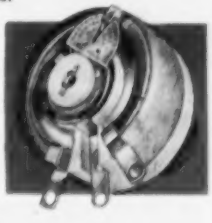
Special design features which make this possible are: an aluminum thru-bar extending through the center of the elliptical ceramic core, which insures a more even distribution of heat to prevent "hot-spots;" and a thermo-shock-proof enamel coating which eliminates crazing.

Heretofore, crazing, which occurred mostly at *terminal* areas, shortened resistor life and limited the safety factor. To prevent this, an alloy with three hard-to-find qualities was needed: (1) It had to have a coefficient of expansion to match all integral parts; (2) it had to be free of gas; (3) it had to form a perfect bond with the enamel.

A large order, indeed. But Driver-Harris filled it by developing #146, a glass-to-metal sealing Alloy. This alloy now makes it possible to operate resistors and rheostats at hitherto dangerous overloads, with no risk of breakdowns in the enamel coatings.

146 Alloy is one of 4 Driver-Harris Alloys which cover most glass-to-metal sealing needs—available as rod, wire, strip, sheet foil, and in special shapes. Today the makers of the "Blue Ribbon" use 146 Alloy for the terminals in all of their resistors and rheostats as well. They also use Nichrome*, Advance*, and other gas-free resistance alloys made by Driver-Harris in winding the cores.

What you can learn from this is clear. If you also need a special purpose alloy, send us your specifications. Our engineers with 48 years of experience are at your service.



One of a new line of "H" Series high wattage rheostats made by Hardwick, Hindle, using Driver-Harris Alloys.

*T. M. Reg. U. S. Pat. Off.

Nichrome and Nichrome V are made only by

Driver-Harris Company HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Louisville, Los Angeles, San Francisco

In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

Don't Gamble With Cable Performance

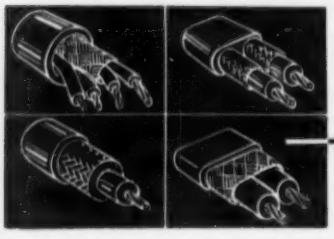
···Depend on PHALO!

"Almost" is never enough when it comes to cable performances. You must be 100% certain the cable you select is custom-made to do the job your power engineering plans call for. You must know you can depend on cable performance in every respect.

Many of America's major users of cables have found they can depend on Phalo to produce *exactly* the cable needed.

Send Phalo a copy of your cable "specs". You'll discover a new kind of cable dependability.

Ask For The Complete Phalo Catalog



PHALO

PLASTICS CORPORATION

The Custom Cable House

CORNER OF COMMERCIAL STREET
WORCESTER, MASS.

Insulated Wires, Cables – Cord Set Assemblies

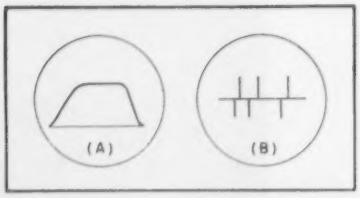


FIG. 3—Vertical (A) and Z-axis (B) inputs to cathode-ray oscilloscope

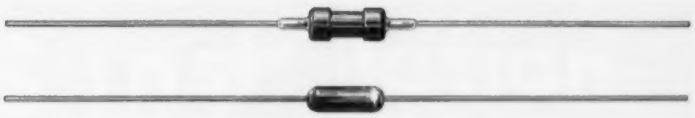
is required to select only one signal at the attenuator. Considerably less hookup time is required. The aligner can simultaneously observe the i-f response characteristics while making specific frequency adjustments. Relatively few distribution cables and transformers are required. Model change-over time is reduced to a minimum.

The overall analysis of the method indicates a substantial reduction in alignment time and a general improvement in the quality of alignment, resulting in better overall performance.

Turn-Finding Welder for Potentiometer Taps

TAPS of hair-size wire are welded to precisely the correct turn on the resistance element of a precision potentiometer with an electronically controlled capacitor discharge welder that allows welding current to flow only at the exact turn that gives the desired resistance value. Tweezers connected to the welder are used to hold the short piece of wire used for the tap. The welding operation is observed with the aid

Automatic welding setup used for welding tap on precisely the correct turn of a precision potentiometer



Amperex®

all-glass GERMANIUM DIODES

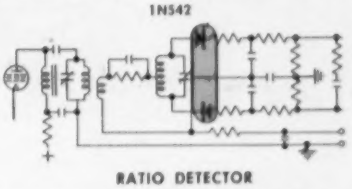
a complete line by a world leader in electron tubes and semiconductors

STABLE • UNIFORM • TIGHT-TOLERANCE

Each AMPEREX germanium diode is all-glass . . . fusion sealed . . . and available in both a clip-in ('GA') and a solder-in ('G') version.

Preferred
ENTERTAINMENT DIODES

- video detector types 1N60G, 1N87G, and OA73
- DC restorer type 1N88G
- AGC and AM detector type 1N541
- matched-pair ratio detector for TV and FM receivers—type 1N542



RATIO DETECTOR

COMPUTER DIODES

- recovery-time and high-temperature tested types
- tight-tolerance, point-contact, high-temperature guaranteed types.

	DIODE TYPE		Recovery Tested	DIODE TYPE
Solder-in	1N480	1N490		1N476 & 1N478
Clip-in	1N119	1N120		1N477 & 1N479
Back Resistance at −20 to −50 volts at 55°C.	400K	200K		Min. and Max. characteristic limits specified at both 25°C. and 60°C. Replace most point-contact types.
Forward Current	5 ma at +1 volt			

GENERAL PURPOSE
and **REPLACEMENT DIODES**

- 100 volt types
- high back-resistance types
- 1 megohm back types
- video detector types

including . . .

1N34G	1N54G	1N63G	1N68GA
1N34GA	1N54GA	1N63GA	1N87GA
1N38G	1N58G	1N67G	1N89G
1N38GA	1N58GA	1N67GA	1N89GA
1N48G	1N60GA	1N68G	1N90G
1N48GA			1N90GA

. . . and other specially tested types

AMPEREX also has available a complete line of audio and switching *transistors* of all-glass construction.

For detailed data or applications-engineering consultation, write to Semiconductor and Special Purpose Tube Department

Amperex ELECTRONIC CORP.
230 DUFFY AVENUE, HICKSVILLE, LONG ISLAND, N. Y.

KEARFOTT
R 900
SERIES
SYNCHROS

for immediate delivery

These SYNCHROS are mass produced in a plant devoted exclusively to their manufacture. This makes the following advantages possible:

HIGH ACCURACY
Probable error 7 mins.
Maximum error 10 mins.

HIGH AND LOW TEMPERATURE STABILITY
Rugged construction minimizes null shift with temperature variations.

CORROSION RESISTANCE
Stainless steel housings, shafts, bearings and laminations.

LOW PRICES:

TYPE	MODEL	PRICE*
Transmitter	RS911-1A	$29.50
Control Transformer	RS901-1A	29.50
Repeater	RS921-1A	31.50
Differential	RS941-1A	51.00
Resolver	RS931-1A	44.00

*Based on 1-25 unit price with leads and standard shaft. Quantity prices on request.

LET US KNOW YOUR DELIVERY REQUIREMENTS — WRITE TODAY

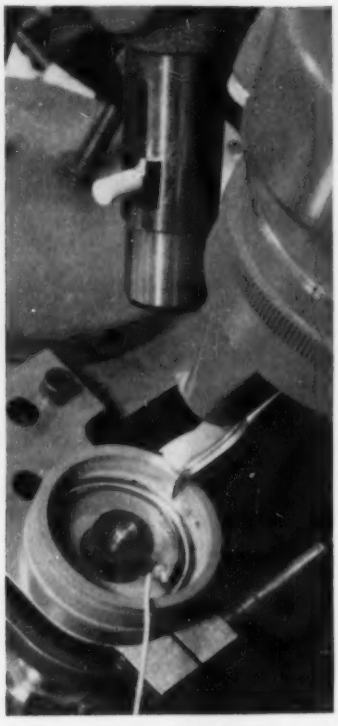
KEARFOTT COMPONENTS INCLUDE:
Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems and other high accuracy mechanical, electrical and electronic components.

Send for bulletin giving data of components of interest to you.

Kearfott

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.
Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.



Closeup of welding operation, showing light source mounted at rear of stereo microscope

of a 20-power stereo microscope, using a spotlight mounted on the assembly fixture to give adequate illumination for this critical operation.

The other terminal of the welder is connected to the wiper arm of the potentiometer, which is set to the desired tap position. With the aid of a calibrating chart, the welder controls are set to a value corresponding to the ohms per turn of the particular potentiometer unit being welded. Sufficient weld current then flows only when the tap wire is on the same turn as the wiper. This technique is used in the Hicksville, N. Y. plant of Fairchild Controls Corp.

Connector Assembly Jig

SOLDERING of nine connectors in correct orientation on the cover of a hermetically sealed airborne electronic control unit is expedited through use of a simple metal jig. A thin sheet of steel having hex holes in the correct positions for the connectors is attached to a

A GATES Installation— IS *truly* A GATES INSTALLATION

Every major item in a **GATES** installation is designed and manufactured by **GATES.**

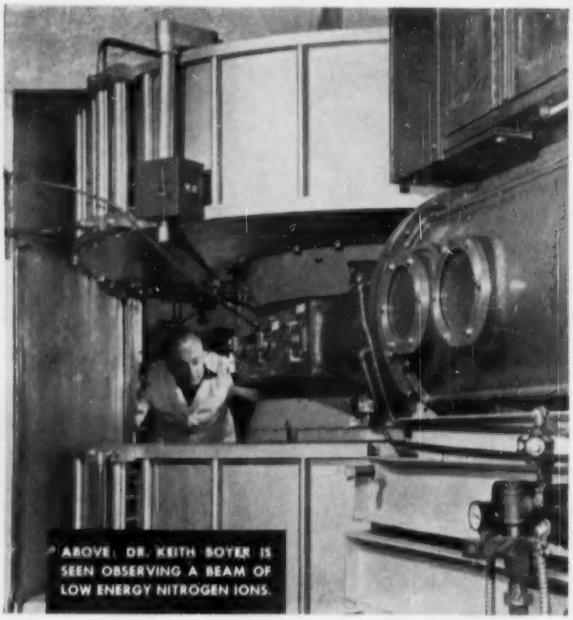
Phasors, turntables, frequency and modulation monitors as well as transmitters and speech input systems, all carry the **GATES** name plate.

This is your assurance of not only the finest but correlated design for electrical and mechanical symmetry without divided responsibility.

GATES
QUINCY, ILLINOIS
U. S. A.

Want more information? Use post card on last page.

BASIC RESEARCH at los alamos



ABOVE: DR. KEITH BOYER IS SEEN OBSERVING A BEAM OF LOW ENERGY NITROGEN IONS.

The cyclotron shown above is one of the many types of advanced research equipment in use at Los Alamos. This variable energy machine is designed to accelerate high intensity beams of all the hydrogen and helium isotopes.

The Laboratory offers a wide range of opportunities to do research and development work in the fields of Physics, Chemistry, Metallurgy, Mathematics, Computing and Engineering.

If you are interested in learning more about career opportunities at Los Alamos, write—

DEPARTMENT OF SCIENTIFIC PERSONNEL
Division 703

los alamos
scientific laboratory
OF THE UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

Placing cover plate over connectors loaded into positioning jig

Touching up soldering on hot plate

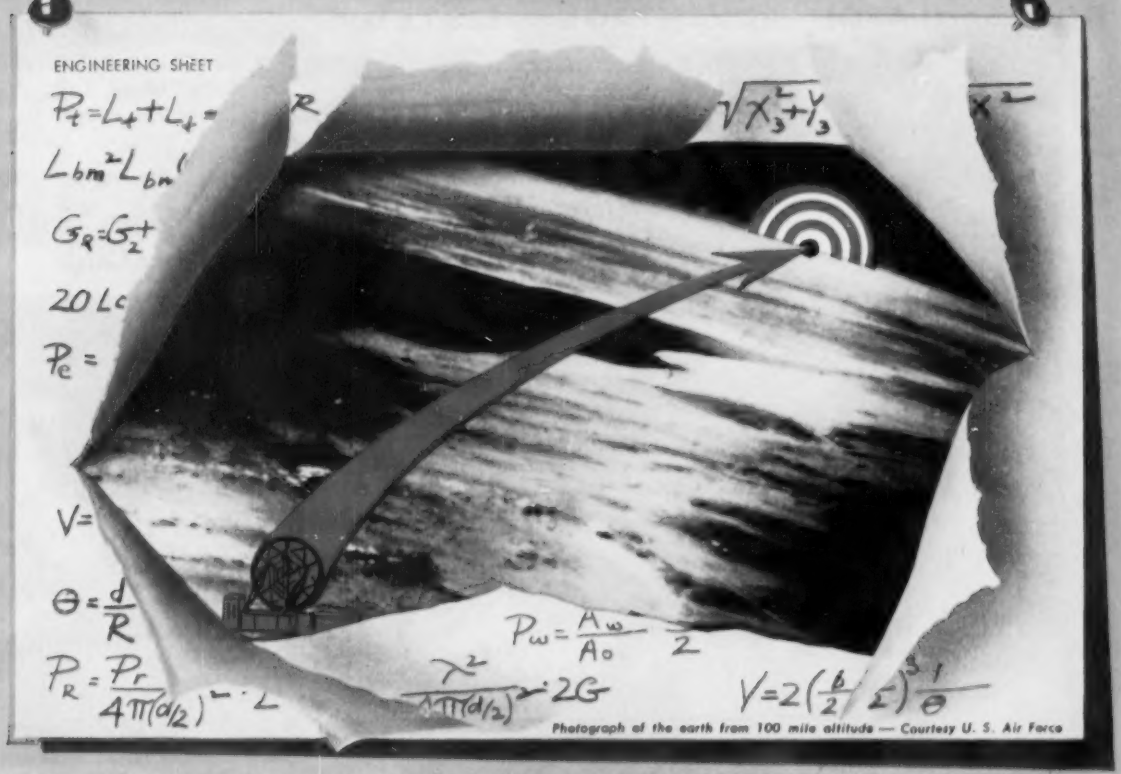
milled-out block of heavier stock.

Alongside each hex hole is stamped the number of the connector. Colored dots are applied at appropriate locations to show the relationship of alignment keys to the plate. Solder preforms are placed over the connectors before the cover plate is put on. The assembly is then placed in an oven for melting of the solder.

After oven soldering, the cover with its connectors is placed on an 800 F hot plate for visual inspection and manual addition of solder as required. The plate is then turned over and three tacks of

PANELOC

A NEW DESIGN APPROACH . . .



. . . BEYOND-THE-HORIZON TRANSMISSION

BEYOND-THE-HORIZON TRANSMISSION

The newest military and commercial long-range communications systems are turning towards the advantages of "scatter" transmission. By transmitting *directly* to stations well beyond the horizon, scatter transmission systems eliminate the construction and maintenance of intermediate microwave stations and avoid cables and repeaters of wire systems, while retaining the wide bandwidths available at high frequencies. This *direct* transmission can span water or inaccessible terrain while giving predictably high signal reliability and freedom from interference.

A NEW APPROACH . . . CONTROLLED SYSTEM DESIGN

A complete analysis including the effects of climate, multipaths, modulation, diversity and prolonged equipment operation combined with an exclusive experimental method of simulating every proposed link enables Hycon Eastern, Inc. to *hit the performance target more precisely*. We can reduce the expense of a large margin for error and eliminate the possibility of costly site relocations by careful assessment of each customer's needs and operating conditions that will provide him with an optimum design.

HYCON EASTERN OFFERS AN INTEGRATED SERVICE

Within the areas of Hycon Eastern, Inc. and its associated companies can be found complete facilities not only to design, engineer and specify equipment for Beyond-the-Horizon Transmission Systems, but to design Central Offices, Connecting Wire Networks, perform Communication Traffic Density Surveys, Aerial Surveys and Mapping to determine the most efficient routes for land lines and for various radio links such as UHF/SHF line of sight. After the necessary facts have been gathered there further exists the experience to evaluate them and to specify practical equipment with complete independence of judgment necessary to create a complete communications system that will fulfill present and projected needs.

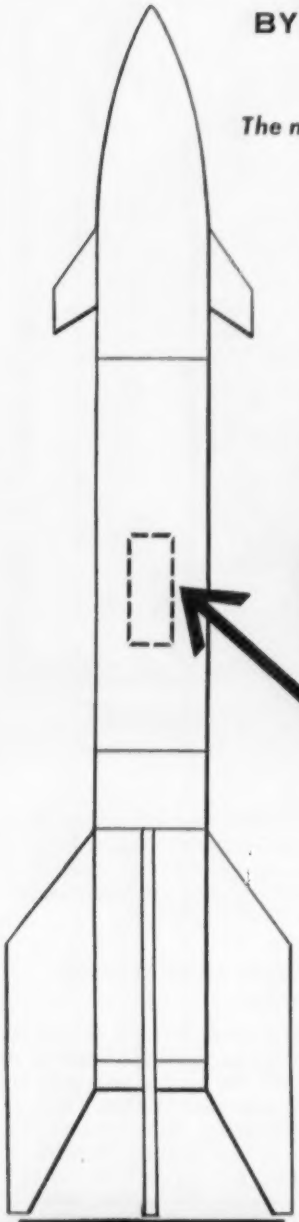
H E HYCON EASTERN, INC.

75 CAMBRIDGE PARKWAY • DEPT. A-4 • CAMBRIDGE 42, MASSACHUSETTS

Affiliated with HYCON MFG. COMPANY, Pasadena, California

Want more information? Use post card on last page.

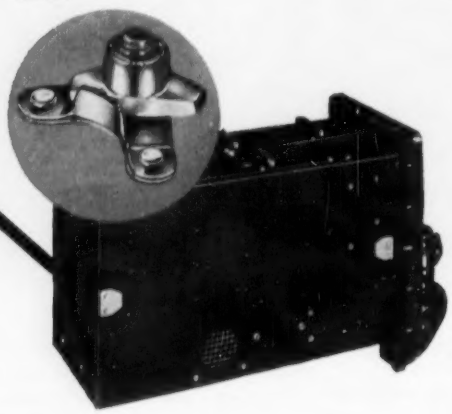
NEW PANELOC
ROTARY LATCH ADVANTAGES LISTED
BY BELL *Aircraft* CORPORATION



The next 135 words of this advertisement taken from Bell Engineers' letters

S. W. Esmond, Product Engineer:

- Electronic equipment shown was designed to use the PANELOC Rotary Latch at a great saving in space and weight, so vital to the aircraft engineer.
- Rotary Latch assembles to door or panel itself—no stud-to-receptacle line-up problem.
- Tests show no sheet separation—fastener locks with the effect of a nut and bolt assembly.
- Vibration tests also had no effect on the Rotary Latch.



F. P. Bassett, Project Engineer:

- Rotary Latch selected for use on cowl access doors on Bell's latest vertical-rising (VTOL) aircraft.
- The new PANELOC Rotary Latch is excellent for hinged doors and applications where maximum access and opening are important design considerations.
- Its simplicity, vibration resistance, ease of installation and cost are other factors that resulted in Bell's adoption of this new fastener.
- Now in use on fixed-wing aircraft, helicopters, missiles, electronic components.

Write for catalog and price list for your file

A PRODUCT OF **SCOVILL**

Scovill Manufacturing Company, Aircraft Fastener Div.
46 Mill Street, Waterbury 20, Connecticut

solder are placed on each nut used on the other side of the cover to prevent loosening from vibration during use. This technique is used in the Long Island City, N. Y. plant of Ford Instrument Co.

Spraying Molten Metal on Resistance Cards

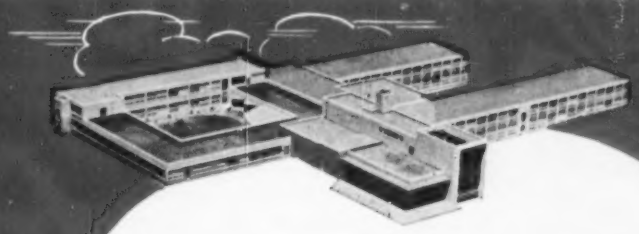
Spraying resistance card with molten metal to form end connections, using combination mask and holding fixture

END connections and shorted sections are produced on wound cards and mandrels for precision potentiometers by masking with a holding fixture and then spraying with molten precious metals in a production setup in Fairchild's, Hicksville, N. Y. plant.

Spraying is done in a metal-lined chamber that catches oversprayed metal. The Metco gun is mounted on the bench at the front of this chamber. The part being sprayed is held by the operator and moved about to insure adequate buildup of metal in the desired areas.

Hoseshoe Bends in Pass-Along Lines

A LONG pass-along assembly line for television i-f amplifiers was set up in an essentially square area in Emerson's Jersey City plant by using six horseshoe bends. The line



Newest ELECTRONIC CONCEPT BY
BURROUGHS CORPORATION RESEARCH CENTER

BEAM SWITCHING TUBE...

AVAILABLE NOW IN PRODUCTION QUANTITIES

Cross Section showing Cathode, Grids, Spades and Targets for 10 position switching.

The beam switching tube offers a new basic device to the engineer of electronic equipment. Versatility of the basic ten-position tube is such that any desired type of sequential, simultaneous or random switching of any number of positions may be obtained. The simplicity of the tube design and associated required circuitry results in a new standard of reliability. It reduces the total number of tubes required in a circuit, space, weight, and heat in control and switching systems.

Perfected by the Burroughs Research Center... rigidly tested and accepted by key electronic plants and communications labs throughout the world...this revolutionary new tube is now precision-manufactured in production quantities with complete accuracy and dependability by the Haydu tube division, specialists in the electronic industry.

The simplicity and reliability of this new basic building block have been demonstrated in applications performing the following functions:

- DISTRIBUTING
- SAMPLING
- FREQUENCY DIVIDING
- COUNTING
- CODING
- MODULATING
- GATING
- TIMING
- CASCADING
- MULTIPLEXING
- MATRIXING
- OSCILLATING

HAYDU

BROTHERS OF NEW JERSEY

PLAINFIELD, NEW JERSEY

Subsidiary of Burroughs Corporation

An Applications Engineering Department, offering engineering service and consultation, has been set up to assist you in taking full advantage of this device. For further information, contact:

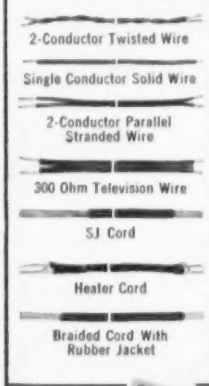
APPLICATIONS ENGINEERING DEPARTMENT
HAYDU BROTHERS OF NEW JERSEY
c/o BURROUGHS RESEARCH CENTER
PAOLI, PENNSYLVANIA

Here's the fastest way to produce finished wire leads!

Allen-Bradley Co., producers of motor controls, use several Artos CS-6 automatic wire cutting and stripping machines in their Milwaukee plant.

high speed ARTOS AUTOMATIC MODEL CS-6

MEASURES, CUTS and STRIPS wire, cord and cable at speeds up to 3000 pieces per hour



3000 STRIPPED WIRE LEADS in one hour ...each precision-cut with both ends perfectly stripped. That's the speedy pace set by the Artos CS-6 in producing wire leads up to 15 inches in length! Production rates vary in proportion to the length cut.

Highly accurate machine operation reduces work spoilage to an absolute minimum. Errors due to the human element are eliminated. ***There is no cutting of strands or nicking of solid wire.***

PROVED PERFORMANCE

Time-consuming hand stripping jobs which once were a bottleneck in many plants are gone forever. As a result, Artos automatic wire strippers are paying their way in the mass production of television and radio sets, electrical appliances, motor controls and instruments of all kinds.

Plan now to cut wire stripping costs in your plant... with the high speed, automatic Artos CS-6.

CS-6 CAPACITY

Finished Wire Leads Per Hour: lengths to 15", 3000; 64"-97" lengths, 500.

Stripping Length: 1½" max. both ends.

Cutting Length: max., 97"; min., 2"; special, ⅞".

WRITE FOR BULLETIN ▶ Descriptive technical sheet tells how the Artos CS-6 can save you money, manpower and time.

Automatic Wire Cutting and Stripping

ARTOS ENGINEERING CO.

2743 South 28th Street • Milwaukee 46, Wisconsin

doubles back and forth across the available area, with an average of six working positions on each of the seven straight sections. The metal panels of this subassembly slide on angle-iron rails, with the rear rail appreciably higher to hold the panel at a more convenient working angle for assembly.

Method of using pliers to push a panel around the bend

When the operator at the end of each straight section completes her work on a panel, she gives it a push with her fingers or with a pair of pliers to send it around the bend to the next operator. Considerable experimentation was required to achieve exactly the right positioning of the angle-iron rails and the sheet metal side fences around each bend, to insure that panels would move smoothly around the bends without jamming or flying off the track.

Folded assembly line for i-f subassemblies, showing one of the six pass-along bends in the two-track line

Insulated

Non-Insulated

Insulated

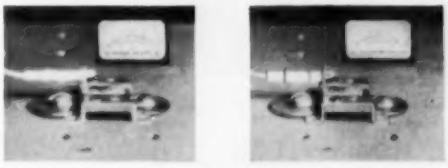
Non-Insulated

TYPE "B" MINIATURE PLUGS AND CONNECTORS
Current Capacity: 5 Amperes
Wire Sizes: #18 to #22

TYPE "C" SUB-MINIATURE JACKS AND CONNECTORS
Current Capacity: 1 Ampere
Wire Sizes: #20 to #22

TYPE "A" PLUGS AND CONNECTORS
Current Capacity: 10 Amperes
Wire Sizes: #14 to #18

VIBRATION PROOF!



Left: With an Interlock Plug and Jack securely mounted, test begins with platen vibrating at 10 cycles per second. Right: at 50 cycles per second, camera stops motion to show plug still locked in its jack! Tested for 18 hours at an amplitude of .06 inch and at a varying frequency from 10 to 50 to 10 cycles per second, conductive quality remained steady with no current interruption during vibration.

For Further Information, Write Dept. C:

HARVEY HUBBELL, INC.
Interlock Electronic Connector Dept., Bridgeport 2, Conn.

SELF-LOCKING HUBBELL CONNECTORS

For additional information on all items on this page, use post card on last page.

New Products

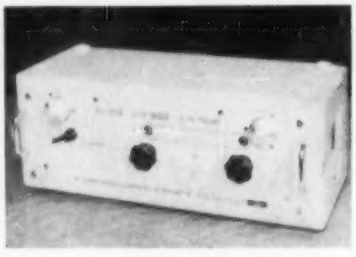
Edited by WILLIAM P. O'BRIEN

80 New Products and 34 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

VHF ATTENUATOR

for accurate, easy operation

FEDERAL TELEPHONE AND RADIO CO., 100 Kingsland Road, Clifton, N. J. Precise measurement of attenuation in electrical elements over a frequency range from d-c to 300 mc may be easily carried out by means of type FT-DTR vhf standard attenuator.



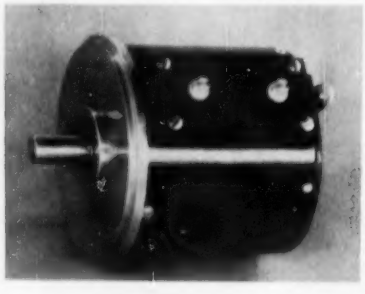
▶ **Performance** — The instrument provides accurate attenuation from 0 to 100 db in 1-db steps, with ease of operation equal to or better than that usually associated with l-f attenuators. It is ideal for attenuation comparison checks and serves also for the attenuation of known voltages where fractional outputs are needed.

The unit weighs 24 lb and measures 19¾ in. long, 7¾ in. high and 10¼ in. deep. It has a characteristic impedance of 50 ohms.

ULTRAPRECISION POT

features high linearity

LITTON INDUSTRIES, Components Div., 336 North Foothill Road, Beverly Hills, Calif. The new 10-turn 2-in. o-d ultraprecision potentiometer provides independent linearity as close as 0.01 percent or better. High stability combined with extra rugged construction assures highest accuracy even under severe environmental conditions.

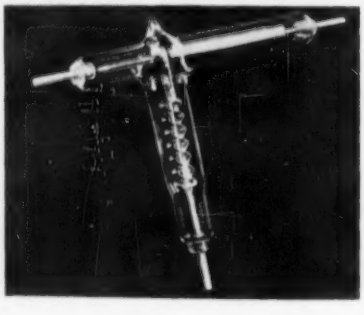


▶ **Construction and Specifications** —The resistance coil is externally wound on a nonhydroscopic ceramic core which is chemically inert, dimensionally stable, and has a low coefficient of expansion. Rugged metal-to-metal traveling nut stops withstand static torque of 500 in.-oz. The wiper arm is independent of the stops and, to minimize wear, only the wiper touches the resistance element. The 2-in. diameter cover is precision-machined aluminum. Electrical angle is 3,600 deg with 90 deg overtravel at each end. All tapes are welded to a single turn of wire. Resistance values of 1K to 100K can be supplied; other values on customer order.

VACUUM SWITCH

is high-current type

PENTA LABORATORIES, INC., 312 N. Nopal St., Santa Barbara, Calif. The PL-169 high-current vacuum switch was developed specifically for switching between spectrograph arc and spark sources, but has numerous other uses where a compact, sealed spdt relay capable of handling 30 amperes at voltages up to 250, or low current at voltages up to 22,000, or both, is required.



▶ **Highlights**—The PL-169 features large contact surfaces, large terminal leads, and a heavy flexible shunt to carry current around the armature. High-vacuum exhaust allows it to withstand a voltage of 22,000 v across the open contacts, even though contact spacing is only 0.020 in.

DIODE CURVE TRACER

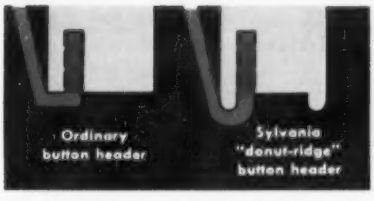
gives large display

WATERS MFG., INC., P.O. Box 368, South Sudbury, Mass. Completely independent display of forward and reverse characteristics of all common types of diodes, on the scope

"donut-ridge"

Button Header

—builds in extra reliability and versatility



Here's a simple reliability test you can make yourself to demonstrate important advantages of Sylvania's "donut-ridge" button header. When you bend the tube leads as shown, ordinary headers will flake, chip, or crack: but leads bend cleanly around the "donut-ridge" header in Sylvania "Gold-Brand" subminiatures.

THE "DONUT-RIDGE" is an original Sylvania refinement in button header design: you'll find it on all Sylvania T-3 premium subminiature tubes. By preventing sharp angle bends in the leads the "donut-ridge" eliminates header cracking and chipping —leads can be clipped short for tight component spacing.

These reliability "extras" are added to the basic advantages of button header design. Greater protection against mechanical shock and vibration; wider lead spacing to retard electrolysis for more stable operation at high temperatures; heavier leads and less lead fatigue; more rigid seating in socket applications; these are just a few of the benefits the button header has over pressed stem construction.

And only the button header accommodates eight external leads which make possible the twin triode with separate cathode connections. Pioneered by Sylvania, the twin triode broadens subminiature application and provides greater versatility in subminiature circuit design.

Standardize your reliable equipment designs with Sylvania "Gold-Brand" subminiatures. There's a "donut-ridge" button header type to meet all your subminiature needs and Sylvania offers you the most complete line. 39 types are detailed in the "Sylvania Gold-Brand Subminiatures" brochure. Write for it. Address department D20P.

SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., Montreal

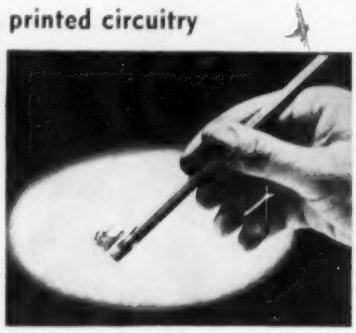
LIGHTING · RADIO · TELEVISION · ELECTRONICS · ATOMIC ENERGY

face of the model 1003B diode curve tracer, gives an image four times the size of that obtained with earlier models. Dual inputs permit convenient comparison or differential testing of diodes and resistors. This facilitates application of the instrument to production testing in addition to its use in laboratory work and as a maintenance tool.

▶**Specifications**—Accuracy is ±5 percent for measurement of forward characteristics at the increased sensitivity of 2 v per in. and current ranges of 10, 20 and 50 ma per in., and of reverse characteristics at 50, 100 and 250 v per in. and current ranges of 1, 10, 100 and 1,000 μa per in. Voltage is adjustable from 0 to 500 v.

PISTON CAPACITORS

used in printed circuitry



JFD MFG. CO., INC., 6101 Sixteenth Ave., Brooklyn, N. Y., has introduced a new series of subminiature piston capacitors designed primarily for use in printed circuitry and automation.

▶**Two Models**—The VC9G ($3 list) and VC10G ($2.50 list) feature glass dielectrics and invar silver-plated rotors. The VC10G measures ⅜ in. in length; model VC9G, ⅝ in.

Temperature range of both goes from −55 C to +125 C and their dielectric strength (d-c volts) is greater than 1,000 v d-c. Adjustment torque is approximately 1 in. oz. Both midget trimmers have a 2-56 internal screw thread, with a 0.118 diameter screw head.

Capacitance range of the VC10G is 1 μμf to 4.5 μμf, and weight is 2 grams. The VC9G has a capacitance range of 0.5 μμf to 8.5 μμf; weighs 3 grams.

H-F DIODES

are silicon bonded

TRANSITRON ELECTRONIC CORP., Melrose 76, Mass. The new silicon diodes, now being produced in a subminiature glass case, exhibit excellent high frequency and fast switching characteristics. They are intended for use in detector, discriminator or pulse circuits where high temperature performance is important.

▶**Highlights**—The bonded silicon diodes offer low shunt capacitance (0.8 μμf average), high inverse resistance and moderate forward conductance with a high degree of electrical and mechanical ruggedness. Types such as the 6SG are particularly useful in 30-to 60-mc i-f strips for video detectors, clamps or clipping diodes. Their fast pulse recovery time is of particular importance for computer circuits as well.

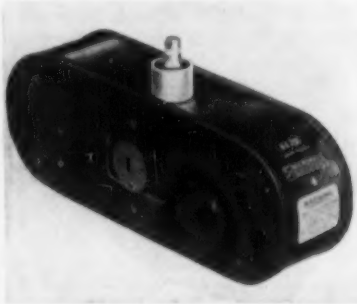
Extremely small size and ability to operate at high ambient temperatures are important advantages when they are used for aircraft and missile applications.

MAGNETRONS

ruggedized, pulse type

MICROWAVE ASSOCIATES, INC., 22 Cummington St., Boston, Mass., has developed two new ruggedized pulse-type magnetrons for continuous operation under extreme conditions of shock and vibration. Both tubes, identical physically, are especially suited for short pulse operation in extremely high-definition radars for airborne and mobile use.

▶**Simplification**—The MA-200 and MA-206 feature much improved form factor packaging with a total weight reduction of 2 lb, simplified mounting requirements and a more compact design than standard 5789. Long life is achieved by use of the dispenser type impregnated tungsten cathode.



The MA-200 is a pulsed-type fixed-tuned magnetron generating approximately 40 kw peak power at 35 kmc. Its r-f spectrum is unchanged when subjected to vibration conditions of 15 g at 1,000 cycles.

The MA-206 is a low-power counterpart of the above generating 20-kw peak power at 35 kmc.

A-F OSCILLATOR

30 cps to 30 kc output

AMERICAN METRIX CORP., Box 179, Upper Darby, Pa. Type 816 a-f service oscillator gives an output

Only

ELECTRO TEC

PRECISION MINIATURE

slip ring assemblies AND COMMUTATORS

offer all these advantages:

EXCLUSIVE* *ELECTRO TEC* TECHNIQUES

insure closer tolerances, absolute uniformity, and the ultimate in miniaturization

Electro Tec units are the product of an exclusive manufacturing technique that results in accuracy unattainable by conventional fabricating methods. In this process a plastic is moulded around the wire leads. Accurate machining reduces this blank to the proper shape, complete with grooves. Hard silver is deposited into the grooves by electroplating to produce the required rings. Final machining insures concentricity and dimensional accuracy. The result is one-piece, unitized construction with conducting rings of 70 to 95 Brinell hardness.

Diameters of these assemblies range from .045" to 24" cylindrical or flat. Cross-sections may range from .005" to .060" or more. Rings are polished to a jewel-like finish and can be held to 4 micro-inches or better. Even the smallest sizes withstand a 1000 V.A.C. breakdown test. Most types easily withstand rotational speeds up to 12000 rpm.

ELECTRO TEC Assemblies are Specified by the Nation's Leading Precision Instrument and Equipment Manufacturers for Proven Greater Dependability, Longer Life, Smoother Functioning.

The uniformly superior performance of Electro Tec slip ring and commutator assemblies in thousands of industrial and governmental applications has resulted in wide adoption of these component units by most leading manufacturers of precision instruments and equipment. Although these products provide improved performance and extra dependability, prices are strictly competitive. Write today for fully illustrated literature.

- ONE PIECE, UNITIZED CONSTRUCTION
- ABSOLUTE MINIMUM TORQUE FRICTION
- DIAMETERS FROM .045" TO 24.0"
- MINIMUM 1000 V.A.C. HI-POT INTER-CIRCUIT
- UNIFORMLY HARD SILVER RINGS PLATED INTO GROOVES ON PRECISION MACHINED ONE PIECE PLASTIC FORM
- SPECIAL SURFACE DEPOSITS PREVENT TARNISH, MINIMIZE FRICTION, BRUSH NOISE AND PRACTICALLY ELIMINATE WEAR

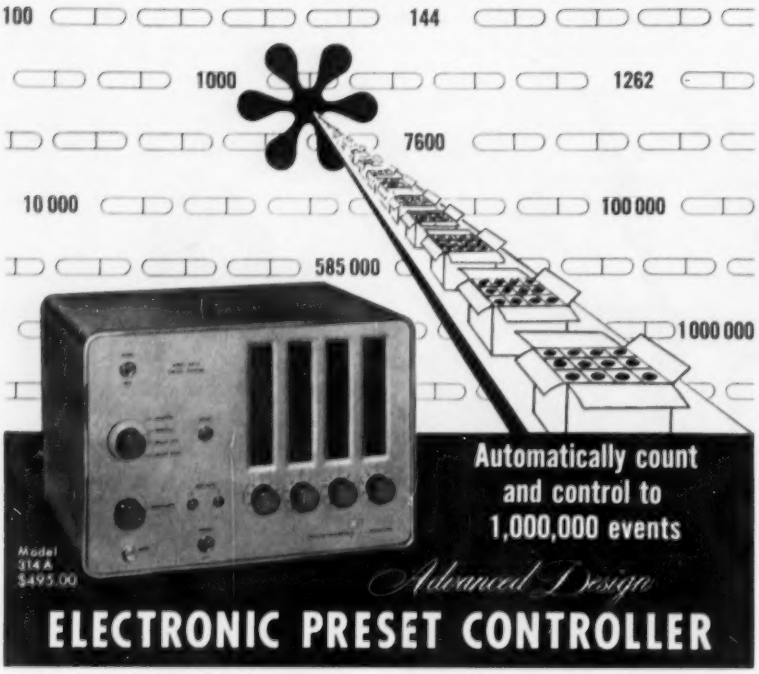
*PAT. NO. 2,696,570

ELECTRO TEC CORPORATION

SO. HACKENSACK NEW JERSEY

PRODUCTS OF PRECISION CRAFTSMANSHIP BY A NEW AND REVOLUTIONARY PROCESS

Want more information? Use post card on last page.



ELECTRONIC PRESET CONTROLLER

The CMC Model 310 Series Preset Controllers are designed as high speed direct reading electronic counters of the coincident type which will control any operation or activate an alarm after a preselected total count has been reached.

***A few of the many applications are batching and packaging of pills, bottles, bottle caps, canned goods, pen points, machine parts, electronic components, etc., in exact preselected quantities; controlling the exact length of stock in cutting operations; and control of high speed machinery.** Any electrical, mechanical or optical events which can be converted into electrical impulses can be counted and controlled. Devices to effect this conversion may be photocells, magnetic coils, switches, and suitable transducers for pressure, temperature, velocity, acceleration, displacement, etc.

SPECIFICATIONS						FEATURES
	312A	313A	314A	315A	316A	
Decades	2	3	4	5	6	
Count Capacity	100	1000	10,000	100,000	1,000,000	
Counts per Second	0 to 100,000 (as totalizing counter)					COINCIDENT TYPE
Recycling Rate	50,000 counts per second (as preset counter)					ABSOLUTE ACCURACY
Input Sensitivity	0.05 volts rms: 10-100,000 cps 0.07 volts rms: 1-10 cps Positive Pulse Rise Time: ½ volt or more per sec.					DIRECT SETTING
Input Impedance	0.5 megohm, 50 mmf					DIRECT READ-OUT
Accuracy	Absolute					EXCEPTIONAL VERSATILITY
Output	60 volt positive pulse, 10 microseconds duration (negative pulse optional)					HIGH SPEED
Output Relay Contacts	5 amps, 117 volts, non-inductive load Normally open or normally closed (with indicator lamps) Can be switched out					RELIABLE
Relay Hold Time	Automatic: Continuously variable from 0.1 to 1 second Manual: Lock until release					RUGGED
Auxiliary Power	6.3 volts ac @ 3 amps; +225 volts dc regulated @ 50 ma; −150 volts dc regulated @ 5 ma.					ECONOMICAL
Power Requirements	117 volts ± 10% 50-60 cycles 100-150 watts depending on model					SMALL SIZE
Dimensions	13" W x 8¾" H x 13" D				16¼" x 8¾" x 13"	
Net Weight	20 to 28 lbs. depending on model					
Finish	Panel: Light grey baked enamel Case: Dark gray baked enamel					
Data Subject to Change Without Notice						

The direct reading Model 101A Preset Decade Counting Unit is designed to provide an output pulse at a selected number at rates in excess of 50,000 counts per second. They are capable of counting at a 100,000 cps rate if reset is not required. These units are readily connected in cascade in order to emit a pulse at any desired count. Typical applications are batching, sorting, packaging, automatic counting and control, frequency division, generation of precise delays, etc.

Model 101A $75.00

Write for complete catalog and prices.

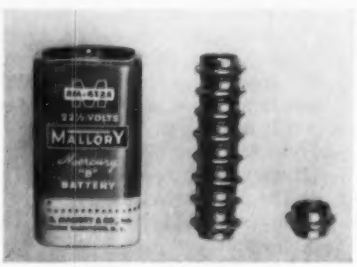
Computer-Measurements Corporation

5528 Vineland Avenue, North Hollywood, Calif. Dept. 78-D

CC-14

from 30 cps to 30 kc which largely covers the acoustic frequency range. It is intended for adjustments of a-f amplifiers and measurements at audio and acoustic frequencies. Output level is adjustable from 10 μv to 10 v by an accurate attenuator system. An automatic regulation circuit keeps the output level constant with changes in frequencies.

► **Further Technical Data** — Frequency accuracy is 2 percent ±2 cps. Output impedance is less than 5,000 ohms. Distortion from 30 to 50 cps is 3 percent; above 50 cps, 2 percent. Power supply is 115 to 220 v, 50/60 cps. Dimensions are 10½ by 7⅝ by 7½ in. Weight is 12 lb, 2 oz.



MERCURY BATTERY
for electronic devices

P. R. MALLORY & CO., INC., Battery Div., North Tarrytown, N. Y., has developed a mercury cell so designed that a number of them can be stacked together to provide required voltage in a variety of physical shapes. The design permits full automation in the construction of the basic cell and in the assembly of the cells into battery stacks, with substantial economies in production costs. Thus the long shelf life and constant

CAN *Ampli*FILM DO THIS?

Many times we have been asked if Ampli-Film Dielectric can be *curved*. We had anticipated applications in which Ampli-Film would be made in shapes other than flat . . .

Yes, *Ampli*FILM can be formed in unusual shapes

The size and shape of some electronic gear require that components be manufactured in unusual shapes. Dielectrics must, in turn, be formed to fit. Ampli-Film meets the requirement. The curved Capitron® Wafer Capacitor pictured is an example. A truly remarkable versatility in a dielectric.

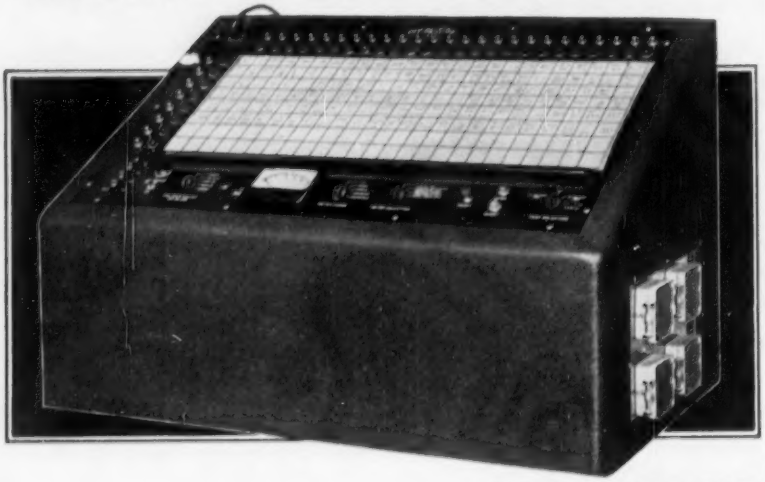
Ampli*FILM** ***the all-purpose dielectric, is insoluble, incompressible and inert . . . undergoes no distortion from heat or pressure . . . can be bonded by adhesives . . . is free from pinholes and flaws . . . is easy to handle and fabricate.

AIRCRAFT-MARINE PRODUCTS, INC.

Chemicals and Dielectrics Division · 155 Park Street, Elizabethtown, Pa.

A-MP of Canada, Ltd., Toronto, Canada • Aircraft-Marine Products (G.B.) Ltd., London, England
A-MP—Holland N.V., 's-Hertogenbosch, Holland • Societe A-MP de France, Courbevoie, Seine, France

ONE DIT-MCO AUTOMATIC CIRCUIT ANALYZER...



...CAN MAKE THE EQUIVALENT OF 35,800 SEPARATE HAND TESTS IN LESS THAN A MINUTE...AND NON-TECHNICAL PERSONNEL CAN DO THE WORK...MORE ACCURATELY THAN WAS EVER BEFORE POSSIBLE BY ANY HAND OR MACHINE METHOD!

If your product involves complex electrical circuitry, DIT-MCO can help you make it better and faster, at less cost. Write today for full details.

DIT-MCO INC., ELECTRONICS DIVISION

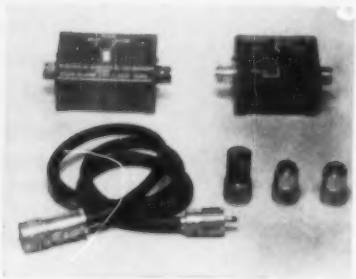
Box 04-15, 911 Broadway, Kansas City, Mo. • Phone: HArrison 1-8484

Partial List of DIT-MCO Users:

Bell Aircraft Corporation, Texas Div. • Bendix Aviation Corporation, Sidney, New York • Boeing Airplane Company, Seattle, Washington and Wichita, Kansas • American Bosch Arma Corporation • Douglas Aircraft Company, Tulsa, Oklahoma • Fairchild Aircraft Division • Goodyear Aircraft Corporation • Martin, Baltimore • Naval Ordnance Laboratory, White Oaks, Maryland • Northrop Aircraft, Inc. • Motorola, Inc. • Temco Aircraft Corporation • Trans World Airlines • Convair • Chance Vought Aircraft • Servomechanisms, Inc. • Radio Corporation of America • Pacific Mercury Television Mfg. Corp.

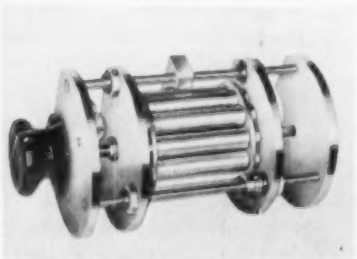
voltage output inherent in the mercury battery system are available at lower prices.

► **Specifications** — The new batteries are available in standard miniature sizes for 15, 22.5, and 45 v. The basic individual cell is 0.490 in. in diameter, with an overall height of 0.280 in. When cells are nested together, the net height of each is 0.210 in.



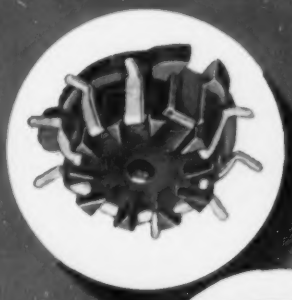
PULSE EQUIPMENT
for wideband transmission

ELECTRICAL AND PHYSICAL INSTRUMENT CORP., 4219 27th St., Long Island City 1, N. Y. A new line offers most equipment needed for wide-band pulse transmission problems from d-c to 1 millimicrosecond rise time pulses (0 to 350 mc), standard coaxial cables prefabricated to any desired length with any desired standard connectors and coaxial line terminations for any impedance from 50 to 200 ohms. Impedance matching boxes for joining different impedance lines, and pulse splitters-mixers, pulse attenuators, and variable pulse delay boxes are included.

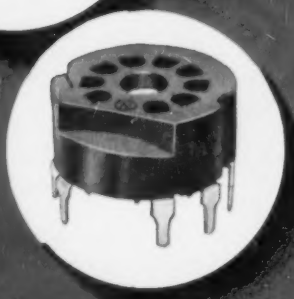


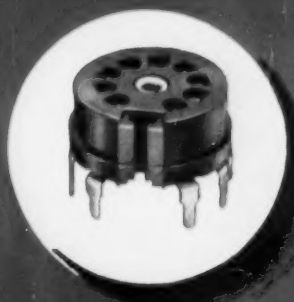
UHF ATTENUATOR
uses coaxial networks

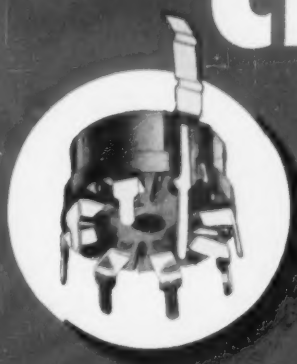
EMPIRE DEVICES PRODUCTS CO., 38-15 Bell Blvd., Bayside, N. Y. Model AT-104 is a 12-position uhf

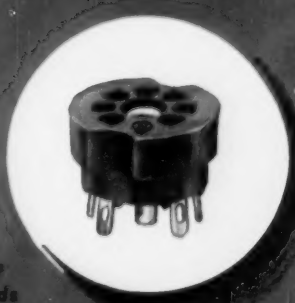


molded printed circuit sockets









IMMEDIATE DELIVERY AND FINEST QUALITY
make ***natfab*** the fastest growing line
of printed circuit sockets

- *available in 7 or 9 pin types*
- *with or without center shields*
- *above or below board soldering*
- *in mica-filled or black phenolic material*
- *with or without ground straps*

WRITE for illustrated or technical literature
Samples available upon request

NATIONAL FABRICATED PRODUCTS
2650 West Belden Avenue • Chicago 47, Illinois
Division of Hoffman ELECTRONICS CORPORATION

Want more information? Use post card on last page.

I'm DALOHM...
miniature but mighty!
You can depend on
DALOHM
TYPE RS
MINIATURE POWER RESISTORS
NEW smaller sizes—ADDITIONAL wattage range
For all applications where the equipment must survive the most severe environmental, shock, and vibration conditions.
Smallest in size; completely welded from terminal to terminal; silicone sealed, offering high di-electric strength, maximum heat dissipation, and maximum resistance to abrasion; impervious to moisture, salt ions, and gases.
RS-2A, 2 watts; RS-2B, 2 watts; RS-2, 2 watts; RS-5, 5 watts; RS-7, 7 watts; RS-10, 10 watts.
• Temperature coefficient 0.00002/Deg. C
• Ranges from 0.05 ohm to 55,000 ohms, depending on type
• Tolerances 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%, 5%
Conform to applicable JAN and MIL Specifications
Write for Bulletin R-23A
DALE PRODUCTS, INC.
Phone 2139
Export Dept.: Pan-Mar Corp. 1270 Broadway New York 1, N.Y.
In Canada: Charles W. Pointon, Ltd. 6 Alcina Ave., Toronto

Relays can be a lot of TROUBLE!
TO THE ELECTRONIC ENGINEER
We know—because we've been making 'em for 40 years. But we admit that we can't pull some answers right off the shelf. Who can—with daily developments in electronics, radar, guided missiles, computers, airborne communications, automation and what have you? We know you're working on certain special projects which may be scheduled for completion next week—next month—or next year. Right now we're interested in the problem you're working on for the future. We know you'll have requirements for relays not now available. And since you are the fellows establishing the spec's, you can avoid trouble by helping us anticipate your needs. Write Mr. E. M. Hunter, Research & Development Dept., Wheelock Signals, Inc., Long Branch, N. J.
Signal Engineering & Mfg. Co., has changed its name to
Wheelock SIGNALS INC.
RELAYS
W S
LONG BRANCH, N. J.

attenuator using resistive coaxial networks.

► **Specifications** — The attenuators are used in both narrow-band and broadband circuits within the frequency range from d-c to 4,000 mc. The vswr is better than 1.1 to 1 at all frequencies to 3,000 mc, better than 1.2 to 1 at all frequencies to 4,000 mc. Rated power is 1 w continuous, 1 kw peak. Accuracy is $\pm\frac{1}{2}$ db. Normal impedance is 50 ohms, with special impedance values supplied on request.

Designed to withstand mechanical shock and vibration, the AT-104 is expected to be widely used both as a laboratory test device, and a production component where flexibility coupled with accuracy is required.

MEASURING SYSTEM
plots vswr vs frequency

COLOR TELEVISION INC., 935 San Carlos Ave., San Carlos, Calif. Permitting instant observation and/or recording of vswr vs frequency, model 125-A sweep-frequency vswr measuring system offers the speed and accuracy of a ratiometer system using a bidirectional coupler. Overall accuracy is within 2 percent.

► **Uses**—The instrument is ideal for wideband tuning operations both in the laboratory or on the production line. Also, where desired, it can be used in single-frequency operations.

Both a built-in oscilloscope and direct-reading meter are provided for direct observation. Where permanent records are required a recorder is available as an accessory. A 203-B klystron with 1,000-cps square-wave modulation is used as an r-f source. The system includes a load calibrated at 4 vswr read-

Notable Achievements at JPL

***FIRST TO FLY FM-FM TELEMETERING...** From JPL's 3-band FM-FM telemetering System flown in 1944, to its present extremely versatile, compact, transistorized 18-band system, telemetering has been an important factor in the successful development of JPL guided missiles.*

Significant firsts in this field are:
In 1948, a 10-band FM-FM System with 15 measurements.
In 1953, an 18-band FM-FM System with 36 measurements.
In 1954, a 14-band FM-FM System with all audio circuits transistorized.

Pioneers in Telemetering Development

JPL JOB OPPORTUNITIES ARE WAITING FOR YOU TODAY!

in these fields

ELECTRONICS
ELECTRONIC RESEARCH
SYSTEMS ANALYSIS
ELECTRO-MECHANICAL
INSTRUMENTATION
INERTIAL GUIDANCE
TELEMETERING
PHYSICS
PACKAGING
MECHANICAL ENGINEERING
AERONAUTICAL ENGINEERING

The success of the Corporal and other JPL guided missile programs is dependent on constantly improved instrumentation techniques. Development, a major portion of the Telemetering Group activity, is directed toward improving system flexibility, accuracy and reliability. This activity is tailored to both immediate and long range instrumentation requirements of the many Laboratory missile programs.

The use of transistors and modern magnetic elements, together with progressive packaging techniques developed from intensive JPL studies, result in greatly improved reliability in missile-borne and ground-recording equipment. In addition, advanced communication studies are being utilized in the design of advanced telemetering equipment to the constant improvement of this art. An example of applied theory, is the use of tracking filter techniques in the communication link—resulting in a significant improvement in telemetering data accuracy.

The size and character of the "Lab" fosters a personal contact and close relationship between data-user and telemetering engineer. This close telemetering support is a basic reason for the development of better ways of measuring drag for the aerodynamicist, motor pressures for the propulsion expert, stresses for the missile designer and of monitoring complex electronic circuits which are the responsibility of the guidance specialist. This close cooperation has become a prime factor in the growth of the laboratory into one of the most successful guided missile development centers in the world.

You are invited to join this progressive group of scientists and engineers. Write us today.

CALTECH jpl **JET PROPULSION LABORATORY**

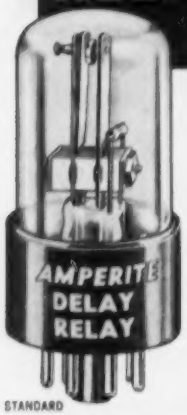
A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA, CALIFORNIA

Want more information? Use post card on last page.

True Hermetic Sealing assures Maximum Stability in AMPERITE RELAYS and REGULATORS

Simplest • Most Compact • Most Economical



STANDARD

MINIATURE

Thermostatic DELAY RELAYS
2 to 180 Seconds

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- *SPST only* — normally open or normally closed.

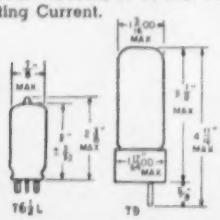
Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from −55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived, and — inexpensive!*
TYPES: Standard Radio Octal, and 9-Pin Miniature

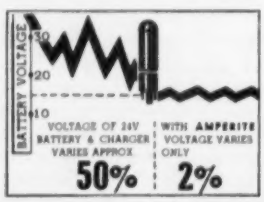
PROBLEM? Send for Bulletin No. TR-81

Also — **Amperite Differential Relays:** Used for *automatic overload, under-voltage or under-current protection.*

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp.) ... For currents of 60 ma. to 5 amps. Operate on A.C., D.C., Pulsating Current.


T6½L T9



T9 BULB

Hermetically sealed, they are not affected by changes in altitude, ambient temperature (−55° to +90° C.), or humidity ... Rugged, light, compact, most inexpensive.

Write for 4-page Technical Bulletin No. AB-51

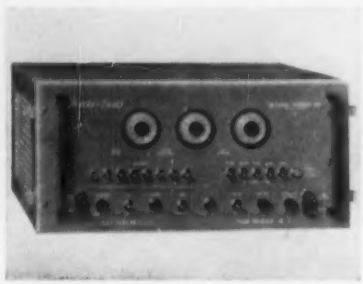
AMPERITE CO., Inc.
561 Broadway, New York 12, N. Y.
Telephone: CAnal 6-1446
In Canada: Atlas Radio Corp., Ltd.
560 King St., W., Toronto 2B

Individual inspection and double-checking assures top quality of **Amperite** products.

NEW PRODUCTS (continued)

ings for each of 3 different frequencies.

▶ **Price**—The complete system including indicator, oscillator, bidirectional coupler and calibrated load is $4,950.



SWEEP OSCILLATOR
priced at $695

KAY ELECTRIC CO., Pine Brook, N. J. The Marka-Sweep model Video 50, a new sweeping oscillator with marks, provides both a 50-mc sweep which includes the low end of the video spectrum, and a continuously variable i-f sweep, enabling the operator to look at the complete spectrum to 50 mc or any 4-mc part over the range.

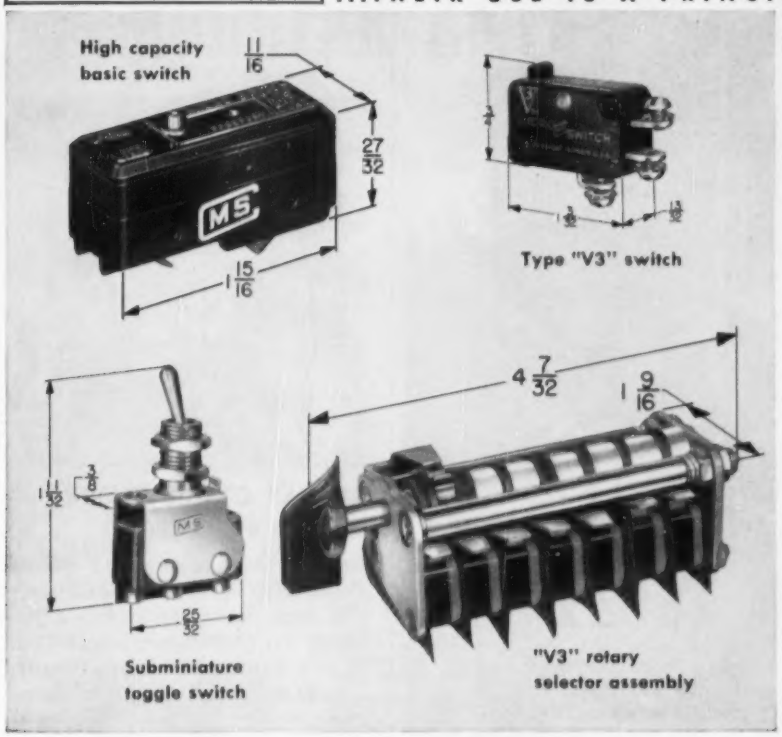
▶ **Specifications**—Range is 50 kc to 50 mc, continuously variable; r-f output, 1.0 v peak to peak into 75 ohms, flat within ±0.5 db over widest sweep; sweep width, linear sweep continuously variable 4 mc to 50 mc; sweep rate, variable around 60 cps, locks to line frequency; attenuators — individually switched 20, 20, 10, 6 and 3 db plus continuously variable 6 db; markers —both internal and external crystal controlled pulse type, individually selected at 10, 20, 30, 40 and 50 mc.

ELECTROLYTICS
are ultraminiature type

BARCO, INC., Box 1222, Milwaukee 1, Wisc. Particularly advantageous for the transistor application where size is of prime importance, these ultraminiature electrolytics are now available in 42 types. Capacitance range is from 0.15 μf to 160 μf, voltage ratings from 1.5 v dcw to 70 v dcw, and diameters from ¼ in. to ⅜ in. The tiny units are hermetically sealed and are inherently

MICRO precision switches

...THEIR USE IS A PRINCIPLE OF GOOD DESIGN



A continuous flow of Precision Switch developments anticipates designer's needs

Whatever the design requirement—whether it calls for unusually small size, unusually high electrical capacity or unusual actuation and circuit arrangement—there is a MICRO precision switch to meet it. That is why designers have long made it standard policy to check with MICRO SWITCH as new needs develop.

Shown here are just a few small, compact switch designs that are typical of MICRO SWITCH development. Each is one of a whole "family" of extremely reliable switches.

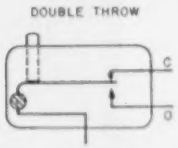
Type "V3" Switch. The MICRO SWITCH "V3" line switches have the highest electrical capacity for their size of any switch available. They have been developed to meet the exacting requirements of designers for an extremely small, compact switch without sacrifice of quality. Actuators are available to permit their actuation by cams, slides and other mechanical motion not in line with the switch plunger motion. (Send for catalog 74).

"V3" Rotary Selector Assembly. These assemblies are available with from one to eight switching units and from two to eight detent positions. Light in weight and small in size, these assemblies are well suited for use in electronic and aircraft applications. Many assemblies are available with various camming sequences. (Send for catalog 74).

High Capacity Basic Switch. This switch combines high electrical rating with high inrush capacity. The steady state current rating is 20 amperes, with inrush capacity of 75 amperes on voltages up to 460 volts a-c. These switches are especially useful for handling high inrush currents of solenoids, motors and tungsten lamps. (Send for catalog 62).

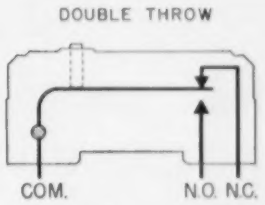
Subminiature Toggle Switch. This is one of a number of subminiature toggle switch designs developed for subminiature assemblies. The toggle switch illustrated consists of one MICRO subminiature switch riveted into the stainless steel toggle bracket. The assembly is for single-pole, double-throw service. Double-throw switches can be used "normally open" or "normally closed" by wiring to either the normally open or normally closed terminals. (Send for catalog 75).

Circuit Arrangements



Type V3 Switch

This switch has a single-pole, double-throw contact arrangement. Electrical rating is: 10 amperes, 125 or 250 volts a-c; ½ ampere, 125 volts d-c; ¼ ampere, 250 volts d-c.

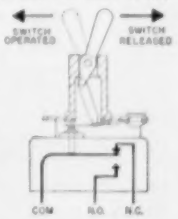


High Capacity Basic Switch

Standard switches are single-pole, double-throw. Electrical rating is: 20 amperes 125, 250 or 460 volts a-c; ½ ampere 125 volts d-c; ¼ ampere 250 volts d-c; 1 H. P. 115 volts a-c; 2 H. P. 230 volts a-c; 10 amperes 125 volts when controlling tungsten filament lamp loads on a-c circuits.

Subminiature Toggle Switch

Contact arrangement is single-pole, double-throw. Double-pole, double-throw assembly, using two subminiature switches is available. Electrical rating is: 5 amperes 125 or 250 volts a-c. The 30 volt d-c rating is, inductive—3 amperes at sea level and 2.5 amperes at 50,000 feet, resistive—4 amperes at sea level and 4 amperes at 50,000 feet, maximum inrush is 15 amperes.



MICRO SWITCH Engineering Service, experienced in precision switching problems, is available—at the MICRO SWITCH branch nearest you. Why not call today?

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

New concept for

HIGH-SPEED TESTING

In just 1 to 2 seconds average, using Hycon's new Model 625 Ratiometer, you can measure directly the ratio of two related DC voltages. It's a real money-saver for quality-control testing on component production lines . . . brings new accuracy and speed to telemetering, measuring VSWR and reading remote transducers. Although completely new, there's no special training needed, for error-free readings are made *directly* on the fast, reliable* 3-digit counter.

Another Hycon test help . . .

MODEL 615 DIGITAL VTVM

Features fast, error-free readout on a reliable, illuminated decimal point 3-digit counter.

*Hycon counters are specially engineered for long service . . . prototypes have been continuously cycled in excess of 1,000 hours . . . the equivalent of at least 20 years of average use. Counters backed by unqualified, continuous-use service guarantee.

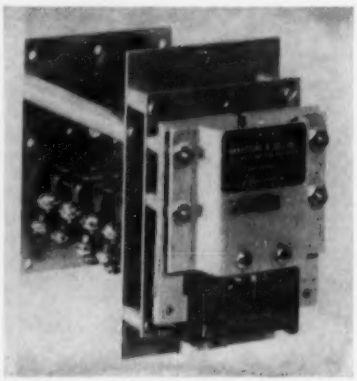
"Where Accuracy Counts"
Hycon ELECTRONICS, INC.
A Subsidiary of Hycon Mfg. Company
321 SOUTH ARROYO PARKWAY
PASADENA, CALIFORNIA

Send TODAY for latest catalogs

HYCON ELECTRONICS, INC., Dept. G
P. O. Box 749
Pasadena, California
Send the latest catalogs on Model 625 and Model 615.

Name_____
Address_____
City_____ State_____

low in leakage current. An operating temperature range of −30 C to +60 C is standard. List price is $1.

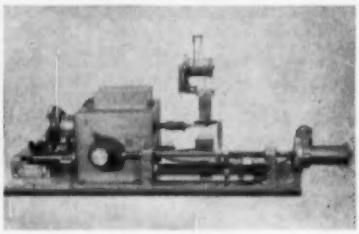


REPEAT CYCLE TIMER
operates on less power

BRAILSFORD & CO., INC., Milton Point, Rye, N. Y. Model AGS-4 repeat cycle timer was developed primarily for balloon instrumentation. It has 4 spdt switching circuits. Overall dimensions are: 3 in. deep; 2¼ in. high; 1¾ in. wide. Weight is 6 oz. Operating current is 8 ma at 6 v d-c. The governor will hold speed to within 1 percent with as much as 50 percent voltage shift, either plus or minus from rating.

It is also available with 1, 2 or 3 circuits and in any required output speed.

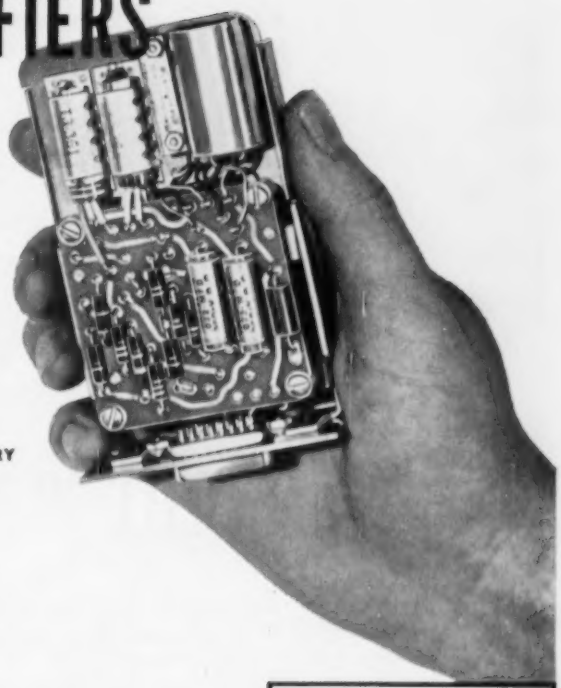
Although primarily designed for semiexpendable applications, units now incorporate a new brush assembly to give normal service life of better than 3,000 hours continuous operation.



COIL WINDER
variable pitch space

GEO. STEVENS MFG. CO., INC., Pulaski Road at Peterson, Chicago 30, Ill., has available a new variable pitch space winder designed for

sub-miniature
MODULAR AMPLIFIERS



- **PROVEN RELIABILITY**
- **REDUCE OVERALL SYSTEM COST**
- **MINIMUM SPACE AND WEIGHT**
- **DESIGNED TO MILITARY SPECIFICATIONS**

REL-18 ISOLATION AMPLIFIER

A Sub-miniature 400 cycle power amplifier, having adjustable voltage gain from unity to 70 with 100 MW power output. The circuit uses triodes with negative feedback reducing the output impedance, phase shift and distortion to a minimum.

REL-19 SUMMING AMPLIFIER

Special purpose sub-miniature 400 cycle amplifier with multiple inputs and single output. The signal output is the vector sum of the input signals times the gain of the amplifier. 14 channel summing accuracy within 2½%. Low output impedance, low phase shift and high stability are achieved by use of negative feedback.

REL-20 SERVO AMPLIFIER

High gain sub-miniature servo-amplifier utilizing push pull output and feedback. 100 MW power output, low phase shift and high stability. Designed to operate into a chopper demodulator.

REL-102 GENERAL PURPOSE WIDE BAND AMPLIFIER

Maximum gain 300. Four course gain ranges with each range continuously variable ± 10%. High input and low output impedance.

REL-103 GALVANOMETER AMPLIFIER

For amplifier piezo electric or low level transducer signals to drive High Frequency Fluid Damped Galvanometers. 70 MA peak to peak into 30 ohm galvanometer.

REL-104 ACCELEROMETER AMPLIFIER

For amplifying piezo-electric accelerometer signals to drive subcarrier oscillator and similar devices. High input impedance and low output impedance. Gain of 10 continuously variable ± 10%.

REL-09

Miniature Telemetering Power Amplifier designed to withstand extreme shock and vibration. 12 watts nominal power output.

for further information call:

RHEEM MANUFACTURING COMPANY

GOVERNMENT PRODUCTS DIVISION

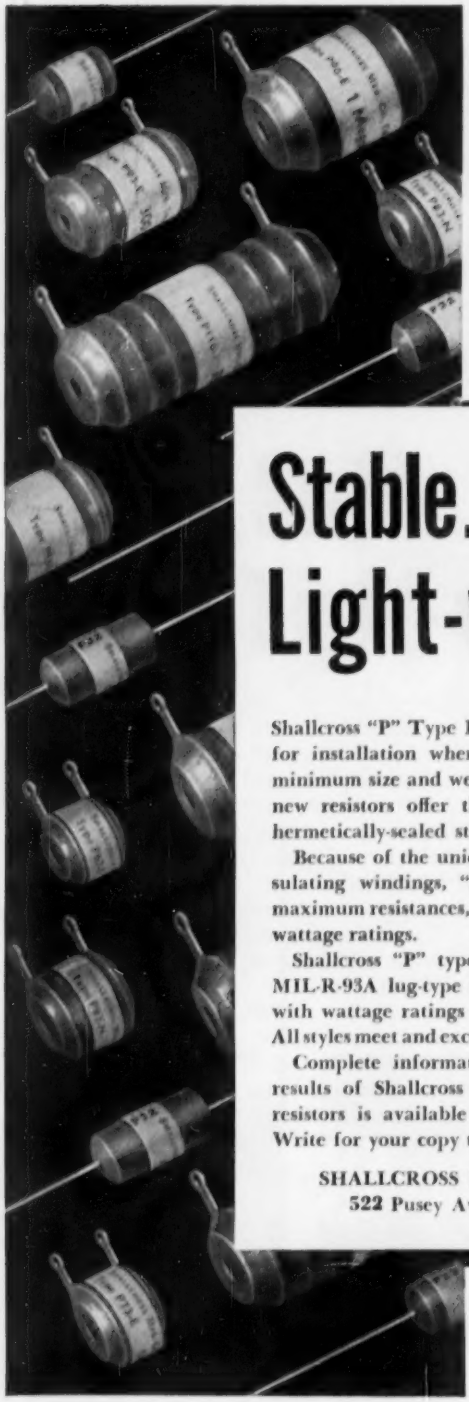
RESEARCH AND DEVELOPMENT LABORATORIES

ELECTRONICS LABORATORY . . . . 9236 EAST HALL ROAD, DOWNEY, CALIF.

Visit RHEEM at booth No. 309 at the I.R.E. SHOW.
March 19 thru 22, 1956
KINGSBRIDGE ARMORY
New York City, N. Y.

You Can Rely on Rheem

Other Plants: DOWNEY, CALIF. • SAN PABLO, CALIF. • WASHINGTON, D.C. • PHILADELPHIA, PA. • BURLINGTON, N.J.



New!

"P" TYPE ENCAPSULATED RESISTORS

Stable...Small... Light-weight...

Shallcross "P" Type Encapsulated Resistors are ideal for installation where stability, dependability, and minimum size and weight are a must. These radically new resistors offer the performance advantages of hermetically-sealed steatite resistors at less cost.

Because of the unique Shallcross method of encapsulating windings, "P" type resistors have greater maximum resistances, longer leakage paths, and higher wattage ratings.

Shallcross "P" type resistors are available in six MIL-R-93A lug-type styles and five axial lead styles with wattage ratings ranging from .500 to 3.5 watts. All styles meet and exceed JAN-R-93A, Characteristic A.

Complete information on sizes, ratings, and test results of Shallcross "P" type precision wirewound resistors is available in Engineering Bulletin L-30. Write for your copy today.

SHALLCROSS MANUFACTURING CO.
522 Pusey Avenue, Collingdale, Pa.

Shallcross

long production runs. It features the electric heel-and-toe pedal which starts the machine and resets the cam for each new winding, permitting the operator to have full use of both hands at all times.

A new time-saving self-resetting automatic counter requires no handling or resetting until turns count is changed, saving much valuable time during long production runs.

Model 518-AM winds variable pitch single layer coils up to 3 in. long by 3 in. o-d. Wire sizes range from 18 to 46. One tension, one gearing set-up, magnetic brake and custom built motor are supplied. Windings speed is up to 2,100 rpm. Complete job changeover takes only 5 to 10 min. Output end of spindle is ⅝ in., flatted shaft, accommodating chucks or mandrel adapters.

CIRCUIT BREAKER for operation to 1,200 cps

AIRPAX PRODUCTS CO., Middle River, Baltimore 20, Md. Type 410 miniature magnetic circuit breaker is now rated for operation from 60 to 1,000 cps. This compact series breaker is thus applicable to a wide variety of airborne installations operating at 400 cps even if the power is subject to wide variations in frequency.

► **Specifications** — Occupying little more than a cu in. of volume and weighing less than 2 oz, this all-magnetic inverse time delay breaker is available in ratings from 1.0 to 10 amperes, 120 v. The hermetically sealed unit is designed for a minimum life of 10,000 on-off operations, resists over 50 g shock and 0.06 in. total excursion of vibration from 1.0 to 55 cps in all

Yes, MARCONI'S
have just what
is needed!
Marconi instruments include a range of Signal Generators designed to meet practically every requirement.

F.M./A.M. SIGNAL GENERATOR
TYPE TF 1066

Carrier Frequency Range: *10 to 470 Mc.* • No spurious sub-multiple outputs; *r.f. oscillator generates direct at carrier frequency on all bands.* • F.M. monitored and variable *up to 100 kc deviation.* • A.M. monitored and variable *up to 80% depth.* • Output Level variable *from 0.2 microvolt to 200 millivolts.* • Precision Incremental Tuning *with frequency change indicated on a directly-calibrated meter.*

MARCONI INSTRUMENTS

VACUUM TUBE VOLTMETERS · FREQUENCY STANDARDS · OUTPUT METERS
F.M. & A.M. SIGNAL GENERATORS · DEVIATION METERS · WAVEMETERS
WAVE ANALYSERS · BRIDGES & Q METERS · AUDIO AND VIDEO OSCILLATORS

Full data and prices will be mailed immediately on request

If you would like to receive our bulletin "Marconi Instrumentation", please mail this

COUPON

to Marconi Instruments, 44 New Street, New York, 4.

Please put my name on the complimentary mailing list for "Marconi Instrumentation", the quarterly bulletin written by engineers for engineers.

Name .....

Company .....

Address .....

City and State .....

UNITED STATES OF AMERICA: 44 NEW STREET, NEW YORK, 4. CANADA: Canadian Marconi Company, Marconi Buildings, 2442 Trenton Avenue, Montreal.
ENGLAND: Head Office: Marconi Instruments Ltd., St. Albans, Herts.
Managing Agents in Export: Marconi's Wireless Telegraph Co. Ltd., Marconi House, Strand, London, W.C.2.

TC 75E

SYSTEMS RAKSCOPE

by Waterman

MODEL S-12-C

INDIVIDUAL SYSTEMS ADAPTATIONS

7" HIGH
10" DEEP

ANOTHER EXAMPLE OF Waterman PIONEERING . . .

The S-12-C series of Systems RAKSCOPES have been developed for the dual purpose of monitoring and troubleshooting of rack-mounted equipment. These oscilloscopes obtain a new degree of flexibility with the multiple input selector making possible selection of different signal sources. This optional vertical input selector, with built-in attenuators, selects either front panel connectors for troubleshooting or rear mounted connectors for systems monitoring. This permits the omission of an entire switching panel from an overall system resulting in circuit and space economies. A ruggedized construction philosophy has been carried throughout. Vertical and horizontal amplifiers are identical, each having a frequency response from dc to 700 kc (—2 db). Their sensitivities are 50 and 72 millivolts rms per inch of deflection. Signal amplitude calibration employs a direct reading meter. The time base is operative in either trigger or repetitive modes with a range from ½-cycle to 50 kc. Synchronization is independent of polarity. Sync. lockout circuits are employed for stable operation over wide range of writing speeds and amplitudes. A unique plug-in elliptical sweep network makes frequency calibrations more simplified. Power requirements: 105-125 volts, 50 to 400 cycles. Accessory probes available; attenuator and amplifier types.

WATERMAN PRODUCTS CO., INC.

PHILADELPHIA 25, PA.
CABLE ADDRESS: POKETSCOPE

MEMO... Write for details today!

WATERMAN PRODUCTS

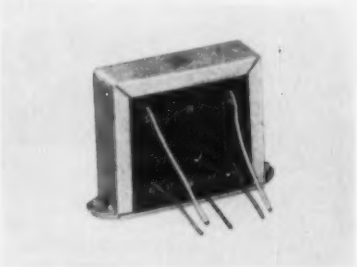
MANUFACTURERS OF

PANELSCOPE®
S-4-C SAR PULSESCOPE®
S-5-C LAB PULSESCOPE®
S-11-A INDUSTRIAL POCKETSCOPE®
S-12-B JANized RAKSCOPE®
S-12-C SYSTEMS RAKSCOPE®
S-14-A HIGH GAIN POCKETSCOPE®
S-14-B WIDE BAND POCKETSCOPE®
S-14-C COMPUTER POCKETSCOPE®
S-15-A TWIN TUBE POCKETSCOPE®
RAYONIC® Cathode Ray Tubes and Other Associated Equipment

®T. M. REG.

directions and maintains its trip level constant from −0 to +100 C.

Because it mounts with a standard switch shank, type 410 trip-free circuit breaker serves both as power on-off control and as circuit protector to simplify equipment wiring and maintenance.

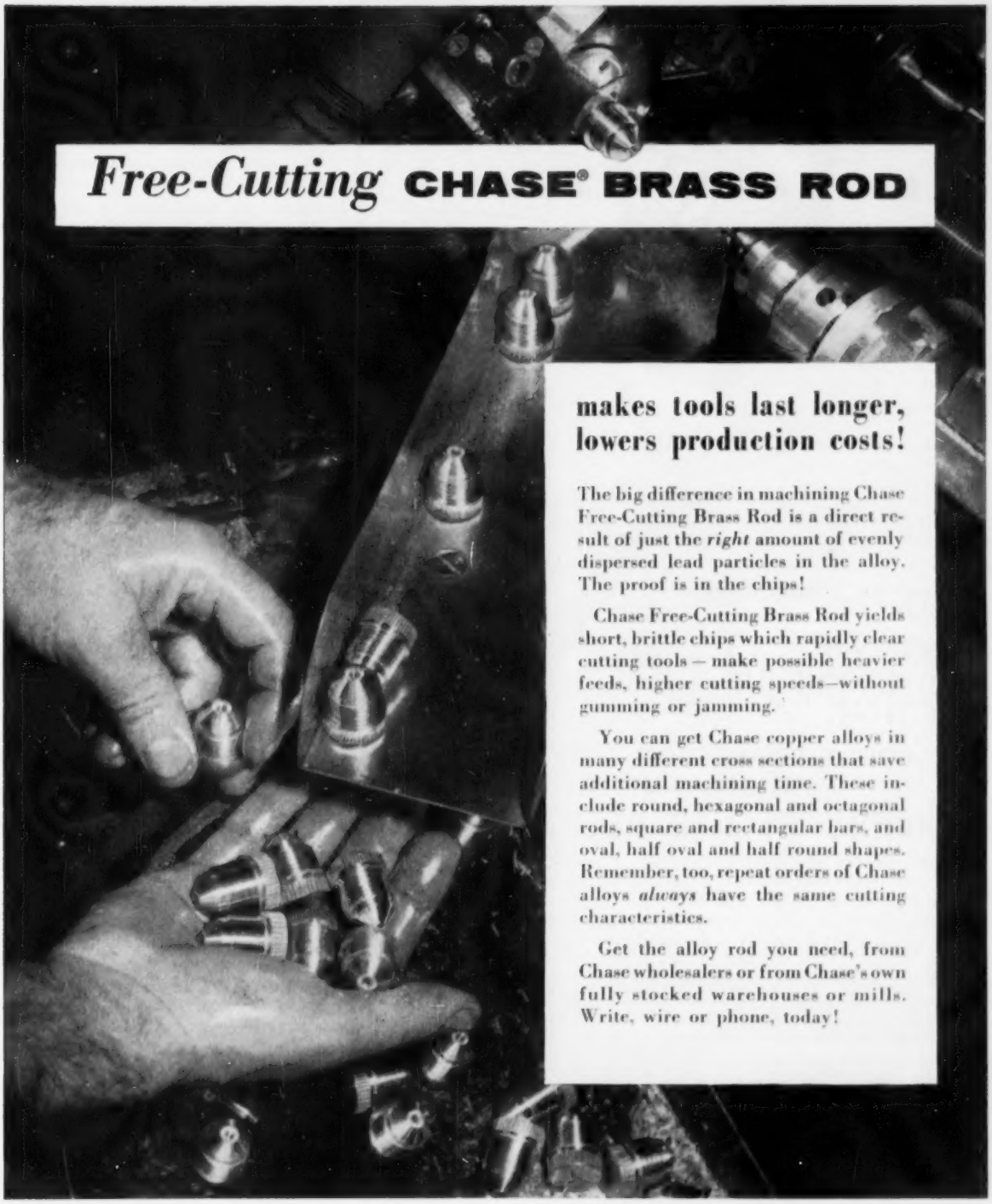


L-F CROSSOVER priced at $13.95

BEAM INSTRUMENTS CORP., 350 Fifth Ave., New York 1, N. Y. The CX500 predetermines the crossover frequency at 500 cps, and has output connections providing l-f from 0 to 500 cps and h-f from 500 cps upwards. Input and both output impedances are 15 ohms. Weight is approximately 1 lb. Dimensions are 4 in. by 3 in. by 1 in.

SINE-WAVE GENERATOR uses etched circuits

DONNER SCIENTIFIC CO., 2829 Seventh St., Berkeley 10, Calif. Model 1200 sine-wave generator generates pure sinusoids from 1 cps to 1 mc (plus overlap) in 6 decade ranges. Distortion is less than 0.1 percent for any frequency or amplitude. Low output impedance of 600 ohms is constant for any setting of the amplitude control. The signal, 0 to 8 v rms, contains no d-c component. Stable amplitude, freedom from



Free-Cutting CHASE® BRASS ROD

makes tools last longer, lowers production costs!

The big difference in machining Chase Free-Cutting Brass Rod is a direct result of just the *right* amount of evenly dispersed lead particles in the alloy. The proof is in the chips!

Chase Free-Cutting Brass Rod yields short, brittle chips which rapidly clear cutting tools — make possible heavier feeds, higher cutting speeds—without gumming or jamming.

You can get Chase copper alloys in many different cross sections that save additional machining time. These include round, hexagonal and octagonal rods, square and rectangular bars, and oval, half oval and half round shapes. Remember, too, repeat orders of Chase alloys *always* have the same cutting characteristics.

Get the alloy rod you need, from Chase wholesalers or from Chase's own fully stocked warehouses or mills. Write, wire or phone, today!

Chase

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

NEW CHASE ROD and WIRE MOVIE "IN THE CHIPS"

Contact your nearest Chase Warehouse or Sales Office now to arrange for a loan of this informative film for showing in your own organization. Write on your Company letterhead.

The Nation's Headquarters for Brass & Copper (Sales office only)

Atlanta	Chicago	Denver	Indianapolis	Minneapolis	Philadelphia
Baltimore	Cincinnati	Detroit	Kansas City, Mo.	Newark	Pittsburgh
Boston	Cleveland	Grand Rapids†	Los Angeles	New Orleans	Providence
Charlotte†	Dallas	Houston	Milwaukee	New York	Rochester†
	St. Louis	San Francisco	Seattle	Waterbury	

COSTLY DESTRUCTION TESTS DEMAND THE RELIABILITY OF A

FAIRCHILD OSCILLO-RECORD CAMERA

Of course, you can always get another piece of equipment to test, set up your instruments, repair your personnel, relandscape the grounds and start all over . . . but it's really easier and less expensive to get the data the first time. Barring a cataclysm like the one above, the Fairchild Oscillo-Record Camera is your best bet for getting accurate records of the test data you want . . . the first time.

Since Fairchild built the first camera specifically designed for oscilloscope recording, more *Oscillo-Record* cameras have been used than all other continuous motion oscilloscope recording cameras combined. The *Oscillo-Record* camera has several design features which contribute to its outstanding reliability and trouble-free operation in obtaining accurate test data. It is ruggedly constructed; its sprocket film drive eliminates slippage, even at high speeds. Rigid, top-of-scope mounting safeguards it against accidental upsetting, maintains the camera in focus at all times and leaves oscilloscope controls unobstructed. Other features include the electronically-controlled continuously variable film speed which permits the selection of the exact rate of film transport for optimum performance.

For any wave pattern . . . continuously varying, stationary or single transient, at all speeds from 1 to 3600 inches per minute, (7200 in/min on special order) the Fairchild Oscillo-Record camera is the reliable means of photographing scope patterns. Industrial Camera Division, Fairchild Camera & Instrument Corp., 88-06 Van Wyck Expressway, Jamaica, L. I., N. Y., Dept. 120-25A2.

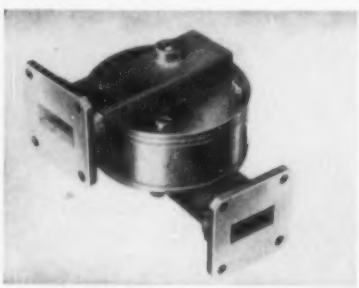
FAIRCHILD

OSCILLOSCOPE RECORDING CAMERAS

drift, and high calibration accuracy are insured by a fully regulated power supply and generous negative feedback.

► **Other Features**—The instrument utilizes a frequency-generator circuit requiring only two vacuum tubes. No wave filter or complex distortion-reducing device is needed. Use of etched circuits and miniaturized components has cut the weight to 23 lb and the size to 7½ by 10½ by 13½ in.

Model 1200 has application wherever high-quality sine waves are essential, as in communications, audio and laboratory testing. Price is $265.



MICROWAVE JOINT
for 1.00 by 0.50 waveguide

AIRTRON, INC., 1103 W. Elizabeth Ave., Linden, N. J., has developed a microwave rotary joint with a peak power rating exceeding 400 kw at atmospheric pressure. The high-power waveguide rotary joint is used with 1.000 by 0.500 waveguide and is available in both unsealed or pressured versions.

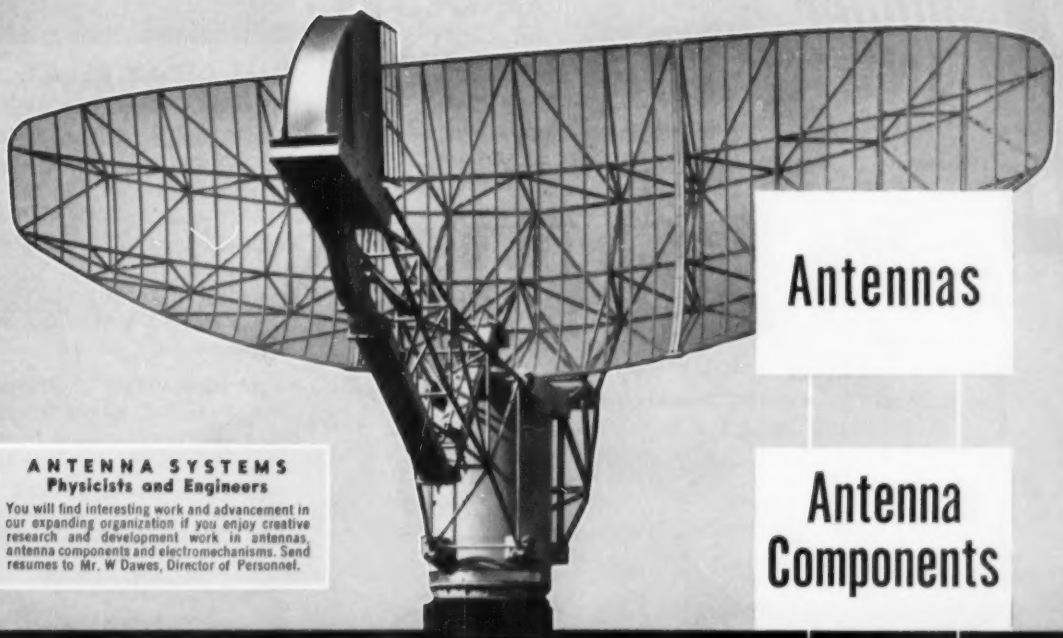
Characteristics include a maximum vswr of less than 1.25 over the 8,500-9,600 mc range and a vswr of less than 1.10 when tuned for narrow-band operation. Variation of vswr with rotation is negligible throughout the total angular travel.

► **Further Data**—Rated for 30 psi pressurization, the rotary joint retained 60 psi without leakage, after rotation at 170 rpm for 10 million revolutions. Mechanical design features assure stability of electrical characteristics throughout the life of the high power joint.

Lasting accuracy of rotation is maintained by large diameter preloaded ball bearings. These bear-

electronics →

Gabriel



ANTENNA SYSTEMS
Physicists and Engineers

You will find interesting work and advancement in our expanding organization if you enjoy creative research and development work in antennas, antenna components and electromechanisms. Send resumes to Mr. W Dawes, Director of Personnel.

Antennas

Antenna Components

Electro-mechanisms

FOR EVERY MICROWAVE APPLICATION

. . . Gabriel can furnish antenna equipment of proved efficiency and reliability. The experience and facilities of Gabriel laboratories offer prompt solutions to your antenna problems. And the manufacturing skills and equipment of Gabriel Electronics Division assure scheduled production to the laboratories' performance specifications.

For analysis of your antenna or microwave problems, write us or telephone NEedham 3-0005 (through Boston).

GABRIEL ELECTRONICS DIVISION
THE GABRIEL COMPANY

NEEDHAM HEIGHTS 94, MASSACHUSETTS
NEedham 3-0005 (thru Boston)

New 2-TERMINAL

SERIES L-6600

Only $1\frac{15}{64}$" long from lens to terminals, this new Hetherington light gives wide-angle visibility in both standard and edge-lit panels. Uses 6, 14 or 28 volt AN-3140 lamps in a unique mounting so light is "piped" evenly throughout the long plastic lens. Lamp circuit insulated from case to meet the needs of electronic equipment. Mounts in $\frac{15}{32}$" diameter hole. Can be supplied with "taper tab" terminals. Also available with l-terminal, case ground, as Series L-6000.

2 smaller INDICATOR LIGHTS

for compact Aviation and Industrial Assemblies

New "PRESS-TO-TEST"

SERIES L-3200

Here's added safety for critical warning light jobs. Lamp and its circuit can be "checked out" before take-off by pressing spring-mounted plastic lens cap. Uses same lamps and lens assembly as L-6600 shown above. Lamp circuits insulated from case. Housed in lightweight anodized aluminum case. Mounts in $\frac{1}{2}$" diameter hole.

OTHER INDICATOR LIGHTS . . . including Hetherington-originated switches with Built-in Lights are regularly produced in a variety of standard and special styles. *Write for Bulletin L-2.*

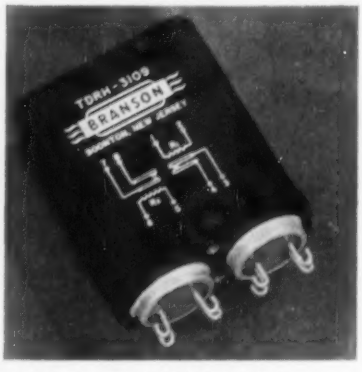
HETHERINGTON, Inc.
SHARON HILL, PA.

West Coast Div.:
139 Illinois St.
El Segundo, Calif.

HETHERINGTON

INDICATOR LIGHTS • SNAP-ACTION SWITCHES
SWITCHES WITH BUILT-IN LIGHTS
HIGH-IMPACT RELAYS • COILS • SOLENOIDS

ings are a premanently lubricated, sealed type which eliminate dirt contamination problems over the life of the bearing.



TIME DELAY RELAY has 2-in-1 feature

BRANSON CORP., Boonton, N. J. The new type TDRH thermal time delay relay uses only 1.531 by 0.844 chassis space and contains two thermal relays which may be completely independent or interwired in various ways to provide special voltage compensated delays as well as other unique results.

▶ **Operation** — The TDRH is hermetically sealed and can be operated in ambient temperatures from −65 C to + 125 C. It will operate properly under the various shock and vibration requirements encountered in high speed military aircraft.

The time delays may be operated at voltages up to 120 v. They require 2 to 4 w of control power depending upon the particular requirements. Normally open or normally closed contacts are available. Standard delays may be anywhere from 1 sec to 1 minute.

EPOXY COMPOUND for potting, encapsulating

HOUGHTON LABORATORIES, INC., 322 Houghton Ave., Olean, N. Y., have available a new epoxy compound, Hysol 6600, especially developed for use in potting and encapsulating large metal masses such as transformers for electronics, instrument transformers, power bushings and related equipment. It has been

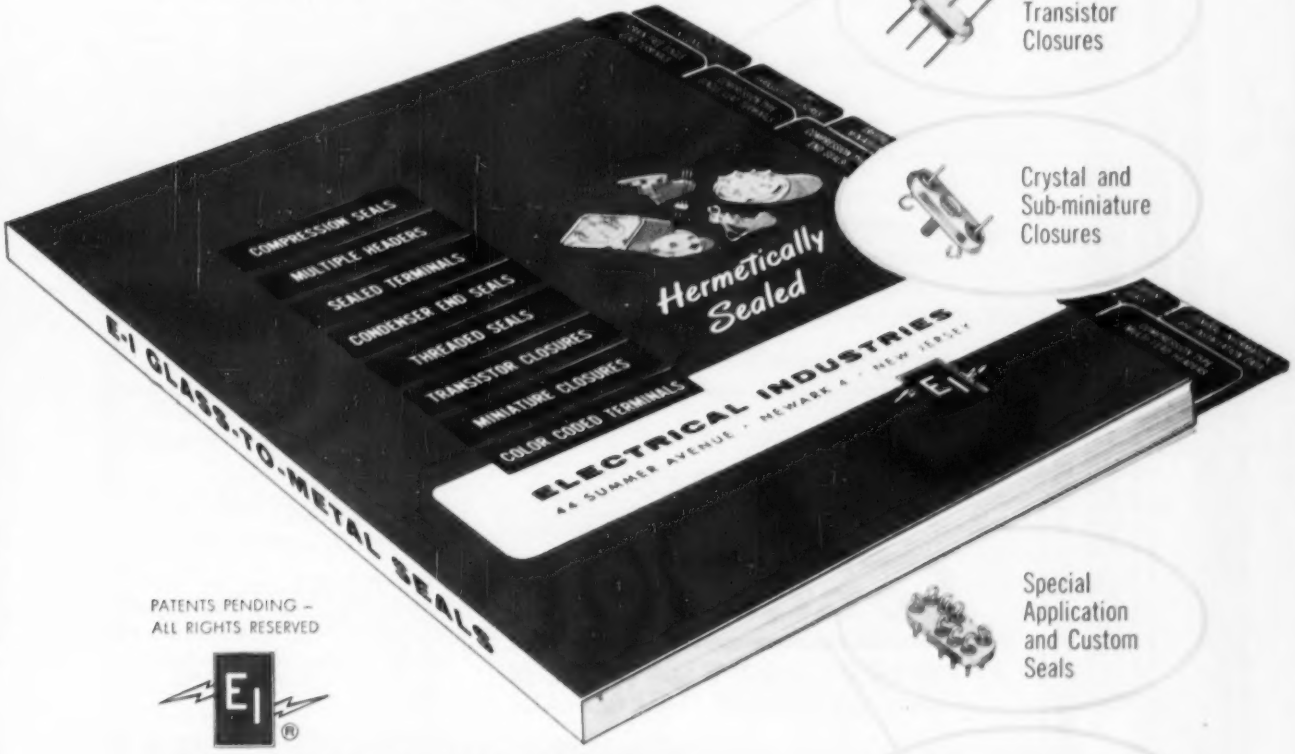
Available now
to Engineers and Designers!

NEW! OVER 100 PAGES!

E-I HANDBOOK and CATALOG

INCLUDES COMPLETE DATA Contains full electrical and mechanical data on over 500 standard types with a helpful discussion of accepted installation techniques.

REQUEST YOUR FREE COPY NOW This authoritative brochure will be particularly useful for design, production and purchasing staffs for specifying, installing and ordering service-proven E-I glass-to-metal seals. To obtain your copy, just write E-I on your company letterhead. A copy will reach you promptly!



Single-lead Terminals

Multi-lead Headers

E-I End Seals

Plug-in Connectors

Diode and Transistor Closures

Crystal and Sub-miniature Closures

Special Application and Custom Seals

Accepted Methods of Installation

PATENTS PENDING –
ALL RIGHTS RESERVED

ELECTRICAL INDUSTRIES

44 SUMMER AVENUE, NEWARK 4, NEW JERSEY

Even for the special "out of this world" wiring problem . . . a down-to-earth solution — Continental Wire

Whether it's a rocket to the moon or a radio for a room—chances are you'll find Continental ready to serve your wiring needs exactly—with both speed and efficiency.

With many quality insulations of Asbestos . . . Glass . . . Nylon . . . Varnished Cambric . . . Polyethylene . . . Polyvinyl . . . Teflon . . . Zytel, among others, Continental also offers a wide range of wire sizes—in stock and on special order. For instance, Continental's ELECTRONIC HOOK-UP WIRE. This nylon-insulated, hook-up wire saves TIME . . . LABOR . . . and GUESS-WORK in assembly. Resistance to abrasion, acids, alkalis and petroleum solvents—and temperatures ranging from —50° C to +125° C —assures dependability plus versatility. Available in AWG SIZES 18 to 32.

One source for your many wiring requirements —Continental. Write today for Continental's complete catalog of heat-resistant, moisture-resistant wires, cables and cords. Serving 600-5000 volts. Sizes, 18 AWG—2,000,000 CM.

Continental's industrial wire and cable specialists are available to serve you at any time.

Contact: Continental Sales, Box 363, Dept. C
Wallingford, Conn., Phone COlony 9-7718

Continental
WIRE CORPORATION
WALLINGFORD, CONNECTICUT • YORK, PENNSYLVANIA

used in transformers which must meet the requirements of MIL-T-27A specification.

Hysol 6600 is a filled epoxy base supplied in the form of a soft solid which melts to an easily handled, low viscosity liquid. A resilient, heat-resistant, tough casting is obtained when this base is processed with Hysol Hardener D.

SILICON TRANSISTOR
for power amplification

GENERAL ELECTRIC CO., Syracuse, N. Y. A power *pnp* alloy junction silicon transistor, the ZJ16 is capable of dissipating 8 w at 85 C and 4 w at 120 C. Maximum storage temperature is rated at 200 C. Maximum collector voltage is rated at 75 v. Alpha cutoff is 100 kc.

► **Applications** — The device will find application in guided missiles, jet igniters, servomechanisms, switching and general amplifier circuits.

It is expected that the ZJ16 will ultimately be the company's answer to the need for reliable power amplification in automobile radios.

TEST JACKS
for printed circuit use

RAYTHEON MFG. CO., 100 River St., Waltham 54, Mass. The new test jacks are miniature units designed specifically for printed circuit application. Consisting of a nylon insulator, a beryllium copper spring pin contact, and a gold-plated contact sleeve, these units are readily mounted in panels up to ¼ in. thick.

Eight colors are available and the

"WE LIKE THE CONSISTENT QUALITY OF RICHARDSON PLASTICS"

SAYS.....

CHICAGO TELEPHONE SUPPLY
Corporation

Exploded view shows a CTS control—a concentric shaft tandem variable resistor with switch. Arrows indicate laminated parts made with Richardson plastics.

SIX PLANTS

NEWNAN, GA.
MELROSE PARK, ILL.
OGDEN, UTAH
NEW BRUNSWICK, N. J.
INDIANAPOLIS, IND.
TYLER, TEX.

RICHARDSON
LAMINATED and MOLDED PLASTICS

Chicago Telephone Supply Corporation is the world's largest producer of variable resistors. To achieve this position, they have stressed *quality*—both in their manufacturing operations and in their sources of supply. For many years, The Richardson Company has supplied the Chicago Telephone Supply Corporation with laminated and molded plastic products which meet their high standards for insulating and electrical properties—a testimonial to Richardson's own quality-mindedness.

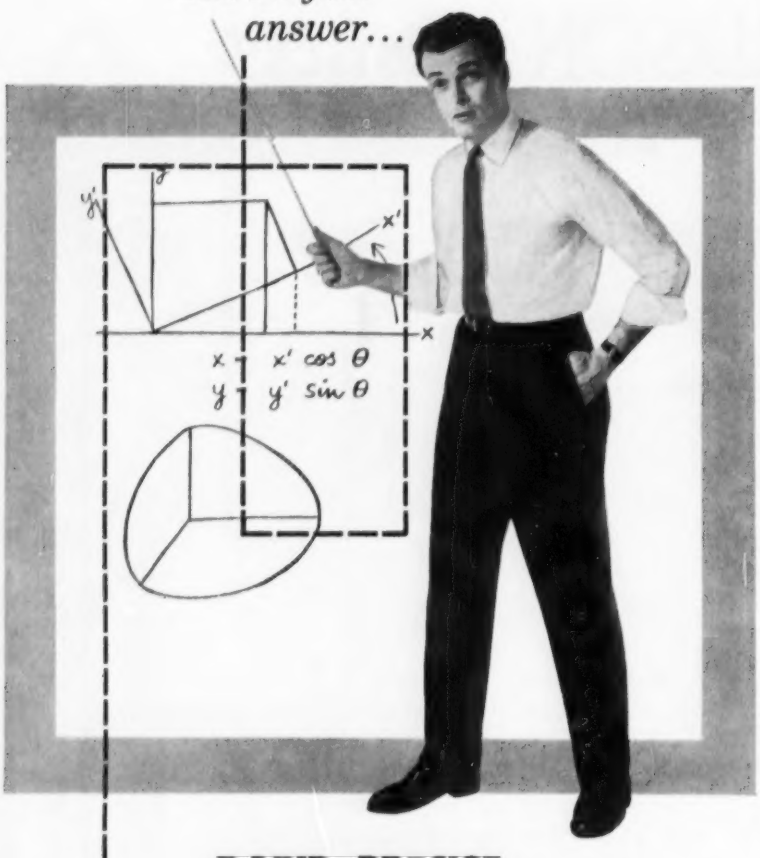
If you are looking for a plastic supplier who can give you what you need, contact Richardson. Their complete laminating and molding facilities permit volume production with consistent high quality and accuracy. Write or phone today for complete information.

The RICHARDSON COMPANY

FOUNDED 1858
2797 Lake St., Melrose Park, Illinois (Chicago District)
SALES OFFICES IN PRINCIPAL CITIES

Want more information? Use post card on last page.

Here's your answer...



RAPID, PRECISE TRIGONOMETRIC OPERATIONS FOR AUTOMATION

Norden-Ketay high-quality resolvers provide you with accurate solutions to problems encountered in:

- High precision phase shifting
- Data Transmission
- Industrial process controls
- Rectangular to polar coordinate transformations
- Rectangular coordinate rotations

These precision resolvers are available to standard sizes (10, 11, 15 or 23) or may be ordered to your specifications.

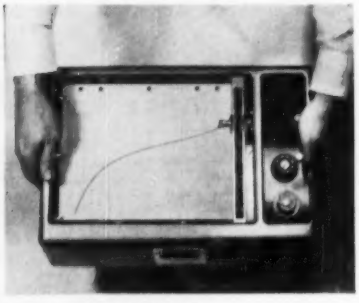
For full details write for data file # 113 .

NORDEN-KETAY CORPORATION

WESTERN DIVISION:
13210 Crenshaw Blvd., Gardena, California
PRECISION COMPONENTS DIVISION:
555 Broadway, New York 12, New York

SYNCHROS · RESOLVERS · SERVO COMPONENTS · AIRCRAFT INSTRUMENTS · SERVO MOTORS · DIGITAL COMPONENTS
PERMANENT MAGNET GENERATORS · PERMANENT MAGNET INVERTERS · STATIC VOLTAGE REGULATORS · FREQUENCY TRIPS

jacks accommodate standard 0.080 in. diameter test prods.



X-Y RECORDER
is light and compact

F. L. MOSELEY Co., 409 N. Fair Oaks Ave., Pasadena 3, Calif. Ideal for desk-top use, the model 3 Autograf X-Y recorder presents standard notebook size graph paper on a flat bed, fully visible to the observer during recording operations. Independent servo drives, actuating a drafting machine type recording mechanism, provide 0.25 percent accuracy and resolution at speeds up to ½ sec for full scale travel, each axis. Inputs are independent and transformer isolated from ground; sensitivity is adjustable in steps from 0.5 mv per in. up to 50 v per in. Zero set and full scale zero offset on both axes allow recording in any desired quadrant.

Completely self-contained, the model 3 Autograf measures 17 in. by 11 in. by 6 in. and weighs about 25 lb. Price is $1,175.

CERAMIC MAGNETS
are highly permanent

STACKPOLE CARBON Co., St. Marys, Pa. A low-cost, ceramic p-m material combines adequate energy product with high coercive force, low residual induction, virtually 100-percent electrical resistivity and exceptional resistance to demagnetization. The Ceramagnet perma-

... Where reliability counts most

Up here Almost 'Good enough' won't do!

Up here, performance must be swift... precise... predictable. "Almost good enough" could mean disaster.

Today, at Norden-Ketay, experienced engineers are meeting missile quality demands in instrumentation for guidance, computors, data transmission, automatic control, components and other vital functions. The same skill and inventiveness responsible for the high level effectiveness of the AN/ASB-1 all weather Bomb Director System, for example, is currently engaged in the development of the most advanced systems for military and commercial use. With the wide range of facilities at their disposal ... with the ability to develop completely new components where needed ... Norden-Ketay is particularly suited to carry out major projects in instrumentation — from development to volume production.

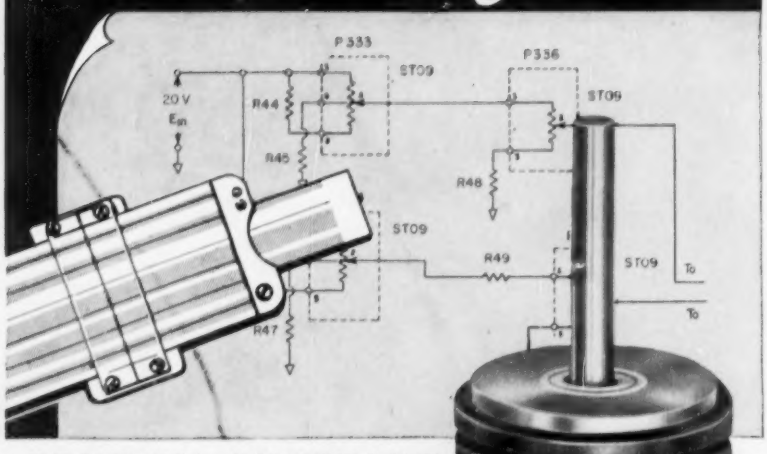
NORDEN-KETAY CORPORATION

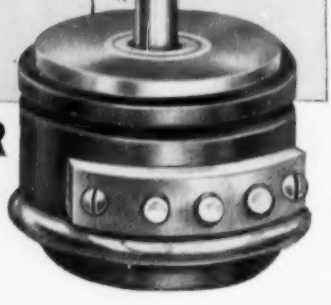
99 Park Avenue, New York 16, New York

SERVOMECHANISM COMPONENTS • PRESSURE GAGES
AIRCRAFT INSTRUMENTS • AUTOMATIC CONTROL
SYSTEMS • RADAR • COMPUTORS

This picture of southwestern U. S. and Mexico is an official United States Navy photograph made from the research rocket, Viking 12, at an altitude of 143.4 miles.

Where specs are tight...





SPECIFY SUPERIOR BALL-BEARING POTENTIOMETERS BY

Designed for those applications where less than the best means failure . . . by the world's first and leading manufacturer of precision single-turn wire-wound potentiometers. Advanced production and quality-control techniques by the pioneer in mass production of precision potentiometers offer unequalled delivery . . . of prototype and production quantities.

All models of the TIC Ball-Bearing Series are designed to the latest industrial dimensions. Servo mounting is AIA standard. Stainless-steel ball-bearing construction is used for low-friction . . . low-torque operation. Other precision mechanical features include precious-metal slider contacts . . . centerless-ground stainless-steel shaft . . . and one-piece stainless-steel clamp ring developed by TIC for simple, precise phasing of individual units of ganged assemblies.

Designed for precision applications in automatic control systems, the subminiature ST09, for example, features standard independent linearity of ±1% (0.3%, special) of the total resistance, and ±5% standard total resistance accuracy. High resolution . . . equivalent noise resistance less than 140 ohms . . . wide standard temperature range (−55°C to 80°C) increases application versatility. ST09 is available in standard resistances of 100, 200, 500, 1K, 2K, 5K, 10K, and 20K.

Full specification on the ST09 and other units of the TIC precision ball-bearing series available upon request.

TECHNOLOGY INSTRUMENT CORP.

533 Main Street, Acton, Mass., COlonial 3-7711
West Coast Mail Address, Box 3941, No. Hollywood, Calif., POplar 5-8620

nent magnets retain their energy even when used without keepers or under other closed-circuit conditions, and in the presence of strong opposing fields.

Ceramagnet magnets are practically nonconductors. Electrical resistivity is 6 by 10^{10} ohms per cm^3, making them ideally suited for h-f and h-v circuits. Temperature characteristics are linear, including retrace, to 400 C.

Units are available in practically any size or shape. Complete engineering data including graphs of essential properties appear in bulletin RC-10A.

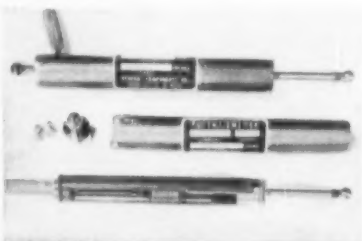
POWER SUPPLY
a precision power source

A-V MFG. CORP., 730 Fifth Ave., New York 19, N. Y. The new precision frequency power supply type 120A is a precision 60-cycle power source with accuracy of 0.01 percent over the temperature range of 0 to 75 C.

The internal precision frequency source is a hermetically sealed 480-cycle tuning fork whose frequency is divided by eight to provide the 60 cycles which drives the unit's power amplifier.

Size is 19 in. wide for rack mounting, height 10½ in. and depth 13 in. Weight is 60 lb net. Input power is 105-130 v, 300 v-a, 50-400 cycles.

Complete details are given in bulletin 120B.



LINEAR TRAVEL POT
in ½-in. diameter case

GENERAL COMPONENTS CO., 801 Eighth St. Southeast, Minneapolis 14, Minn., announces a new, miniaturized linear travel potentiometer. Either single or dual pots are available in a ½-in. diameter case. Ball type mounting provides

MISSILE WEAPONS SYSTEMS PLANNING

The successful development of advanced missile weapons systems demands a high order of creative planning and coordination between scientists and engineers in virtually every field. Individual efforts must fit smoothly into group progress covering a span of years.

At Lockheed Missile Systems Division, regular planning conferences coordinate the progress of weapons systems development – from initial operations research and systems analysis to operational use.

Significant new activities at Lockheed have created openings for those able to contribute to group efforts of the utmost importance.

Systems Analyst Jobe Jenkins (standing) discusses planning on a new weapons systems project with research and development personnel involved in initial development activities. From left to right: E. A. Blasi, antenna; G. D. Schott, flight control; W. D. Van Patten, command guidance; Jenkins; H. R. Senf, electronic research; W. F. Main, radar; J. J. Dulin, electronics systems analysis; E. V. Stearns (back to camera), advanced systems design.

Lockheed

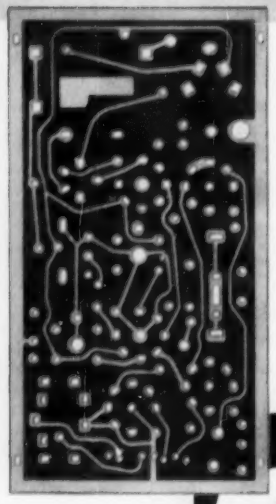
MISSILE SYSTEMS DIVISION

research and engineering staff

LOCKHEED AIRCRAFT CORPORATION

VAN NUYS, CALIFORNIA

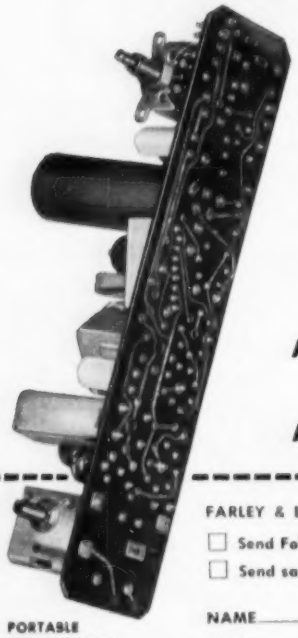
FARLITE®



TYPICAL PRINTED CIRCUIT

High Pressure
PLASTIC LAMINATES for PRINTED CIRCUITS

P-630B



PORTABLE RADIO CHASSIS USING FARLITE P-630B

This much-wanted grade of paper-based plastic laminate is now available in substantial quantity. Through exercise of our special skills and manufacturing facilities, rigid U.S. Government and NEMA Standards are met, and are exceeded in every instance. Present users of our P-630B laminate report excellent results, particularly in significant reduction of manufacturing costs. Use the coupon below to learn more about . . .

A RELIABLE PRODUCT *from* A RELIABLE SOURCE

FARLEY & LOETSCHER MFG. CO., DUBUQUE, IOWA

☐ Send Folder No. 1933 showing all FARLITE laminates.

☐ Send sample of FARLITE P-630B.

NAME_____

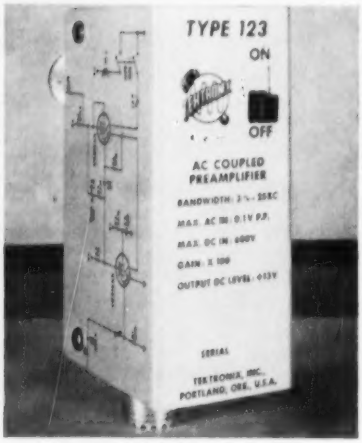
FIRM_____

ADDRESS_____

universal alignment. Resistance values are up to 60,000 ohms per in., total travel up to 6 in.

▶ **Performance** — Dual wipers are on each element for minimum noise and longer life. Resolution can be as low as 0.0008 in., with single turn taps. It has O-ring sealed construction to meet environmental requirements of MIL-E-5272A.

Unique design permits complete preassembly and testing before insertion in case.



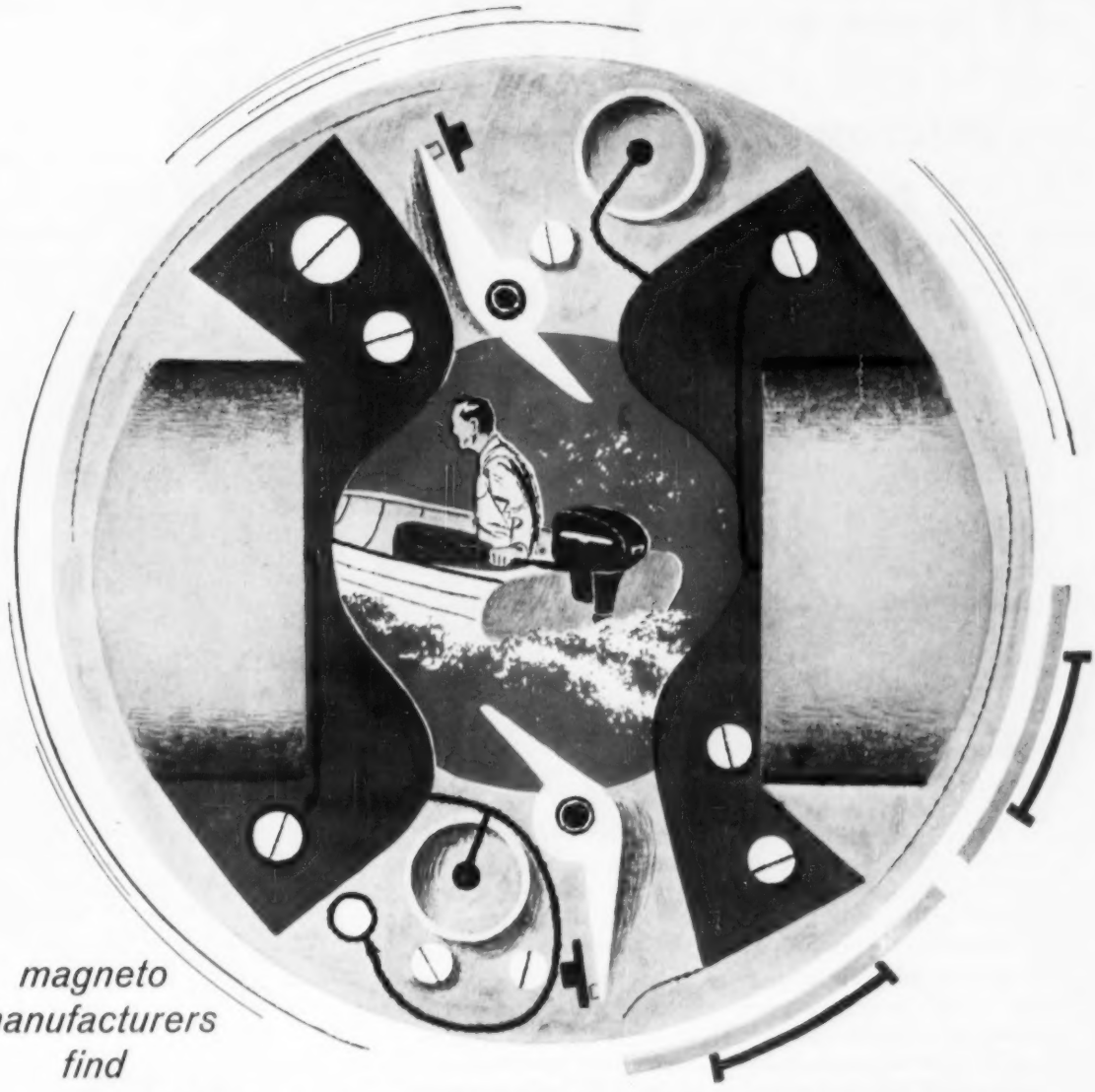
PREAMPLIFIER
battery-powered, a-c coupled

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type 123 is a battery-powered a-c coupled preamplifier with a voltage gain of 100. Passband is within 3 db from 3 cps to 25 kc, within 2 percent from 15 cps to 6 kc. Maximum input signal is 0.1 v peak-to-peak.

▶ **Other Features**—It is fitted with coaxial input and output connectors, permitting mounting on an oscilloscope or other instrument, or mounting to a cable for use as a probe. Dimensions are 3¾ in. high, 1½ in. wide, 2⅞ in. deep, not including connectors. Weight is only 10 oz. Price, including batteries, is $50.

SPECTRUM ANALYZER
for h-f use

MARCONI INSTRUMENTS, 44 New St., New York 4, N. Y. The OA1094 spectrum analyzer gives a visual



magneto manufacturers find

CRUCIBLE PERMANENT MAGNETS

provide maximum energy... minimum size

The *consistently higher* energy product of Crucible Alnico permanent magnets enables manufacturers to use smaller, more powerful magnets in the magnetos of outboard motors, power mowers and other gasoline-powered equipment.

In fact, ever since Alnico alloys were first developed, Crucible has been supplying them to manufacturers of permanent magnet magnetos, generators and motors and all types of magnet-equipped devices.

Pioneers in magnet design and production, Crucible's magnet division is backed by a half-century of fine special steelmaking. So when you have a magnet application it will pay you to call Crucible. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Eccosorb CH
Microwave Absorber
for Darkrooms

Microwave Darkroom with
Emerson & Cuming Luneberg Lens under test

Eccosorb CH is a series of broadband absorbers reflecting less than 2% of the energy incident upon its surface. It is composed of enmeshed, rubberized fibers and made in sheets 2 feet by 2 feet in various thicknesses. Eccosorb CH is light weight and flexible. It is easily mounted and its natural, white surface color gives good light reflection.

Free Space Rooms are easily and economically built for indoor antenna measurements. Reflections are eliminated for all practical purposes. You can build your own microwave dark room or **we offer you a complete Free Space Room ready to use.** Emerson & Cuming engineers design and build special types for unusual conditions. Send us your specifications.

Another absorber, ECCOSORB HF comes in rods, sheets or molded shapes in several volume resistivities for waveguide terminations and similar uses. If you have a problem write for information on . . .

Plastics for Electronics

Emerson & Cuming, Inc.

869 WASHINGTON STREET, CANTON, MASS.

PLASTIC FOAMS
LAMINATING AND IMPREGNATING RESINS
PLASTIC-FIBER GLASS LAMINATES
HIGH DIELECTRIC CONSTANT PLASTICS
METALIZED PLASTICS
ELECTRONIC EMBEDMENTS
CASTING RESINS
LOW LOSS ROD AND SHEET STOCK
MICROWAVE ABSORBERS

Sales Representatives

DAYTON
ROBERT G. SIFF & ASSOCIATES
11 W. Monument Bldg., Dayton 2, Ohio
Hemlock 1254

KANSAS CITY
ENGINEERING SERVICES COMPANY
4550 Main Street, Kansas City 11, Mo.
Jefferson 7765

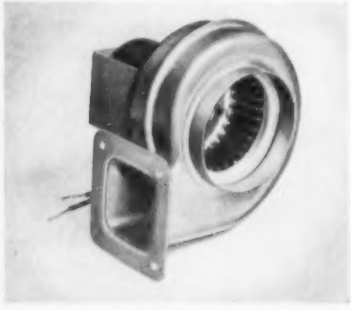
NEW YORK
M. RAYMOND KALLMAN
P. O. Box 104, Roslyn, L. I., New York
Roslyn 3-6511

ST. LOUIS
ENGINEERING SERVICES COMPANY
6635 Delmar Blvd., St. Louis 5, Mo.
VO 3-3661

WASHINGTON, D. C.
TED BRITT
1500 Mass. Ave., Washington 5, D. C.
Columbia 5-2694

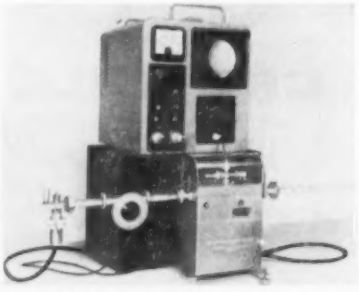
WEST COAST
McCarthy Associates
P. O. Box 36, Altadena, Calif
Sycamore 8-5790

presentation on a crt of the frequency spectra of a-m signals in the 3 to 30-mc band. Bandwidth can be switched to either 6, 30 or 150 cps and the sweep amplitude can be varied from 0 to 30 kc and scanning time from 0.1 to 30 sec. Using a two-stage measurement technique, relative signal amplitude levels of 60 db can be measured.



CENTRIFUGAL BLOWERS
cool electronic equipment

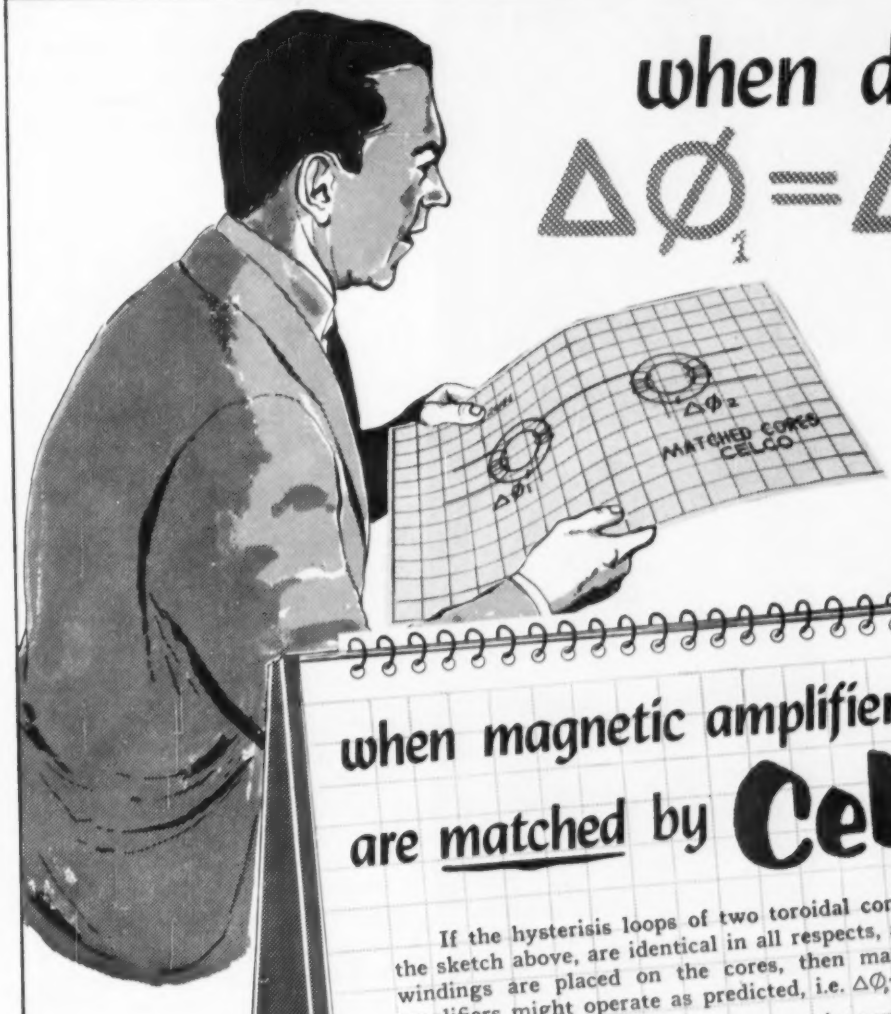
TRADE-WIND MOTORFANS, INC., 7755 Paramount Blvd., Rivera, Calif. Series PA-361 blowers are being used in cabinets and other housings for ventilating electronic equipment. Compact in design, they employ centifugal blower wheeels and produce up to 130 cfm with shaded pole motors. Overall dimensions are approximately 7 in. in length, width and depth.



S-W INDICATOR
speeds component testing

MARCONI INSTRUMENTS, 44 New St., New York 4, N. Y. The TF1081 automatic standing-wave indicator provides rapid and accurate vswr measurements by means of a motor driven waveguide probe. The unit includes a modulated klystron oscillator, and the output from the probe is amplified and displayed on

when does $\Delta\phi_1 = \Delta\phi_2$?

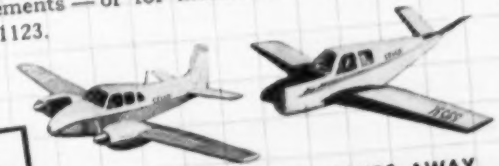


when magnetic amplifier cores are matched by Celco

If the hysterisis loops of two toroidal cores shown in the sketch above, are identical in all respects, and identical windings are placed on the cores, then many magnetic amplifiers might operate as predicted, i.e. $\Delta\phi_1 = \Delta\phi_2$

However, even if the above assumptions were true, then subsequent handling, impregnation, encapsulation and electrical history of the assembly must be carefully controlled in order to maintain the original performance characteristics. Here at Celco, a considerable amount of development and production experience is available for application to your particular magnetic amplifier problems.

We shall be happy to quote on your magnetic amplifier component requirements — or for immediate action — call RAmsey, N. J., 9-1123.



Celco

YOUR PLANT IS ONLY HOURS AWAY FROM MAHWAH BY THE CELCO AIR FLEET

Constantine Engineering Laboratories Co.

Island Avenue, Mahwah, New Jersey — RAmsey 9-1123

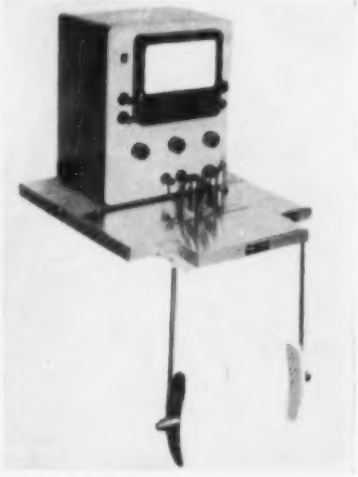
Manufacturers of precision aircraft and missile electronic components: ★Radar Yokes ★Motor Stators, Armatures Rotors ★Transformers

DONNER MODEL 1200
SINE WAVE GENERATOR

Less than 0.1% distortion, any amplitude or frequency
1 cps to 1 mc in 6 decades, plus overlap
600 ohms constant output impedance
Many other exceptional features
Small, portable – 23 pounds
$265.00, FOB Factory

DONNER SCIENTIFIC COMPANY
2808 Seventh St.
Berkeley, Calif.
Complete data
on request.

the synchronized crt. Frequency range is from 8,500 to 9,500 mc and the accuracy of vswr measurement is 0.5 percent. Minimum discernible vswr is 0.995.



TEST BRIDGE
fast impedance comparator

BRUSH ELECTRONICS CO., 3405 Perkins Ave., Cleveland 14, Ohio, has introduced a new addition to the line of deviation test bridges, extremely fast direct-reading impedance comparison instruments.

▶ **Uses**—The instruments are used primarily for production inspection, inspection of resistance, capacitance and inductance. They are designed to accurately and quickly present a comparison against a standard impedance indicating both percentage impedance deviation and phase angle deviation in radians on a 6-in. illuminated scale.

The new deviation test bridge model BL-1506 has a 100-kc bridge frequency for the test ranges 10 to 50,000 ohms resistance, 25 $\mu\mu$f to 0.1 μf capacitance, and 20 μh to 80 mh inductance.

For automatic inspection the meter can accommodate 4,000 units per hour.

KNOB LOCK
for electronic controls

RAYTHEON MFG. CO., Waltham 54, Mass., has announced a new locking device for use on potentiometers and other electronic controls. De-

Miniaturized Hi-Voltage

QUALITY CARTRIDGE RECTIFIERS BY

International

Manufactured under the United States Army Signal Corps Reduced Inspection Quality Assurance Program
RIQAP

A WORLD OF DIFFERENCE THROUGH RESEARCH

The higher voltage ratings of International selenium rectifier cells result in a 30% shorter length cartridge! These miniature-size rectifiers permit greater design freedom where space is at a premium. They are available in numerous terminal types, circuits, cell sizes and protective coatings to meet your specific needs. International—leader in the field—sells more selenium cartridge rectifiers than all other manufacturers combined! As a result, your special cartridge rectifier requirements may be standard at International. A wire, letter or phone call will bring immediate and experienced recommendations for your application.

International Rectifier

CORPORATION

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA · PHONE OREGON 8-6281

NEW YORK: 112 E. 70TH ST., TRAFALGAR 9-3330 · CHICAGO: 205 W. WACKER DR., FRANKLIN 2-1883
IN CANADA: ATLAS RADIO CORP., LTD., 50 WINGOLD AVE., W., TORONTO, ONTARIO, RU 1-6174

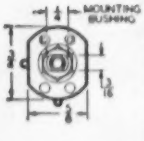
THE WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS

Save valuable space in compact equipment

Signal Corps Type AN/PRC-10 Walkie-Talkie. Designed and built by RCA to Signal Corps specifications.

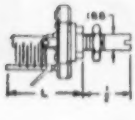
a complete line of JOHNSON variable capacitors

Whether you're looking for a tiny "M" capacitor similar to the one shown above, or a rugged air variable rated to 11,000 volts, you're sure to find it in the Johnson line. All Johnson Variable Capacitors are designed to permit high standards of workmanship, yet costs are low.



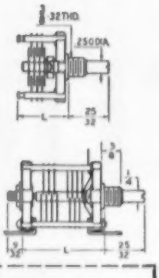
TYPE "M" CAPACITORS

Extremely compact and rugged—requires ⅝" x ¾" panel mounting area. Soldered brass plates. Low inductance bridged stator terminals. Heavy beryllium copper rotor contact nickel plated. Steatite end frames, DC-200 impregnated. Heavy nickel plating, standard — other platings available.



TYPE "L" CAPACITORS

Excellent for applications requiring extreme stability and rigidity—tie rods soldered directly to ceramic (steatite) end frames. Plates and metal parts, brass—plating is heavy nickel — other platings available. Requires 1⅜" x 1⅜" panel mounting area.



Johnson also makes a complete line of

SHAFT COUPLINGS • FLEXIBLE SHAFTS • PANEL BEARINGS

Flexible and rigid shaft couplings available for ¼" to ¼", ¼" to ⅜", and ⅜" to ⅜". Types available for adjustment to both axial and angular shaft misalignment.

Flexible shafts are phosphor bronze with ¼" nickel plated brass hubs. Permit out-of-line or up to 90 degrees angular control with minimum backlash.

Panel bearings are nickel plated brass—for ¼" shaft and up to ⅜" panels. Types available with 3" and 6" nickel plated brass shafts—standard ⅜"-24 nut furnished.

For complete information and specifications on Johnson Air Variable Capacitors or other Johnson electronic components, write for your copy of components catalog 976a.

E. F. JOHNSON COMPANY

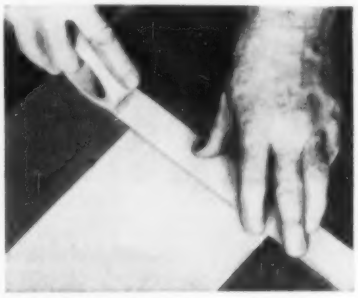
2304 SECOND AVENUE SOUTHWEST • WASECA, MINNESOTA

CAPACITORS • INDUCTORS • KNOBS • DIALS • SOCKETS • INSULATORS • PLUGS • JACKS • PILOT LIGHTS

signed for application with Raytheon standard control knobs, the knob lock mounts on the control bushing replacing standard mounting hardware and provides a simple means of maintaining critical control settings under conditions of shock or vibration.

It takes up little more panel area than the knob itself. An eighth-turn of the fluted skirt forces a circular neoprene shoe against the inner face of the control knob, locking the knob firmly without affecting the angular position of the control shaft.

The knob lock is available in three sizes for use with series 70, 90 and 125 round Raytheon standard control knobs.



TEFLON TAPE
now in cementable form

THE UNITED STATES GASKET CO., Camden 1, N. J., is producing Teflon tape—treated for cementing with any commercial adhesive, to metal, glass, wood, plastics or any other surface. Pull test is approximately 45 lb.

▶ **Applications** — Thin section (down to 5 mil) inexpensive applications of this material can be made for many purposes where

what's the

veridicality

of a DeMornay-Bonardi standing wave detector?

Verily, it's high. Since you want true readings from a slotted line, we've produced an instrument abounding in "truthfulness."

First we massacred the causes of mismatch. The D-B waveguide block, for example, is precision-formed in one piece to give it high internal uniformity. This pays off in an even path for the measured waves. Also, it minimizes residual VSWR. To wipe out warpage, we make the block of non-distorting, stress-free aluminum, precision-milled to assure absolute alignment with the probe carriage. Three leveling screws support the instrument without rocking.

Do we stop there? Not by your transverse travel! We use a 5-point kinematic carriage suspension which assures maximum linearity of probe motion. The carriage rides on stainless steel ball bearings, precision ground and spring loaded to keep perfect alignment. A large knob controls the carriage motion from a restful stationary position, leaving eyes free to watch the indicator. Knob speed is continuously variable from "vernier" to "fast," allowing you to speed up the quick measurements.

Your budget buys more. For a modest amount, you can equip any D-B instrument to handle another frequency band. Merely use a different size waveguide block and probe. Nine sizes of each are available—all interchangeable in 30 seconds, without loss of accuracy. Thus one instrument will measure from 12.4 KMC to 90 KMC and another from 5.8 KMC to 12.4 KMC.

Who needs tuning? D-B broad band probes with calibrated depth adjustment need no tuning over the allocated waveguide band, and yet are efficient at all frequencies. There's a special built-in miniature coaxial cable that flexes freely with the carriage motion, eliminating 95% of cable noise. Many more refinements in addition. Complete data sent on request.

DE MORNAY BONARDI

DEMORNAY-BONARDI • 780 SOUTH ARROYO PARKWAY PASADENA, CALIFORNIA

Want more information? Use post card on last page.

ACTUAL SIZE
Where
ACCURACY
SIZE
WEIGHT
RELIABILITY
Count
Most
FOR AC SYSTEMS SPECIFY CPPC SYNCHROS
Let Clifton Size 8's take the place of larger synchros at very significant savings in weight and bulk, yet at no sacrifice in accuracy or reliability.
In airborne equipment, why load on unnecessary weight?
By the early introduction of our Size 8 Synchro Series, we figure to have saved the Air Arm 1 Ton of dead weight in 1956 alone.
Samples from stock, quantities from the production line.
Write for complete electrical data.
cppc SIZE 8 SYNCHROS
ACCURACY 7 MINUTES
WEIGHT 32 GRAMS
LOOK TO
cppc
FOR SYNCHRO PROGRESS
CLIFTON
PRECISION
PRODUCTS CO., INC.
CLIFTON HEIGHTS, PA.

Teflon's extremely anti-hesive sanitary surface, zero water absorption, chemical inertness, broad service temperature range and unusual dielectric qualities are desired. Teflon tape, treated for adhesion on both sides and laminated to another dielectric for rigidity, also offers excellent possibilities for printed circuit production.

Cementable Teflon tape, 5 mil to 60 mil in thickness is available in continuous rolls up to 12 in. wide. Sheets are also available in $\frac{1}{32}$-in. thickness in sizes up to 24 by 24 in. and in $\frac{1}{16}$-in. thickness, up to 48 by 48 in.

SMALL RECTIFIER
for printed circuits

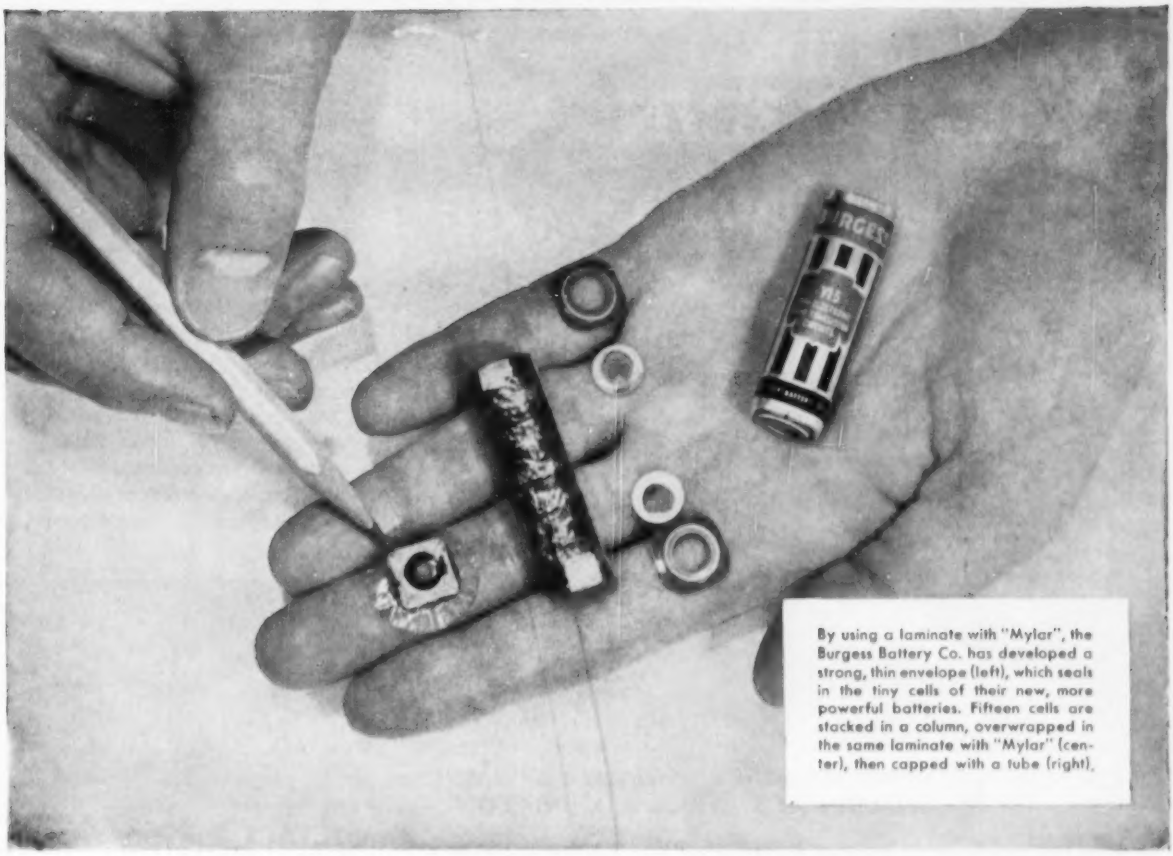
RADIO RECEPTOR CO., INC., 251 W. 19th St., New York 11, N. Y., has announced a new miniature selenium rectifier with special snap-in terminals designed for printed wiring boards. The terminals will snap into the printed board easily, but with sufficient mechanical rigidity to hold the rectifier firmly in place, making soldering necessary only for good electrical contact.

▶ **Ratings**—The new rectifiers are the half-wave stack types 8Y1B and 8J1B, rated at 30 ma and 65 ma, respectively, at off the line voltages, with a capacitive load in an ambient temperature of 45 C.

Both stacks mount in $\frac{3}{16}$ diameter holes spaced on $\frac{31}{32}$ centers.

AMPLIFIER
light-weight, small space

SERVO CORP. OF AMERICA, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y. Model 1124 Servoflex amplifier is designed to meet the light-weight, small space and



By using a laminate with "Mylar", the Burgess Battery Co. has developed a strong, thin envelope (left), which seals in the tiny cells of their new, more powerful batteries. Fifteen cells are stacked in a column, overwrapped in the same laminate with "Mylar" (center), then capped with a tube (right).

Du Pont MYLAR® helps Burgess obtain smaller, more powerful batteries

"Smaller than your finger tip, yet a third more powerful than conventional cells . . . that's the story of improvement on our line of dry-cell batteries", reports the Burgess Battery Company, Freeport, Ill. "We achieved this improvement by using a laminate with 'Mylar'* formed into an envelope to seal in tiny dry cells. Because the lamination is extremely thin, we saved valuable space for more energy-producing materials.

"By using this same laminate with 'Mylar' as the insulating cell-stack wrap, the old problem of holes appearing in the overwrap after heat sealing has been completely eliminated. High chemical resistance and strength make it possible to heat-mold each cell into a permanent locked position to preserve the intercell connection. What's more, the transparent material permits maximum quality control . . . inspectors can see into each cell-stack to insure perfect stacking and wrapping."

This is only one example of the way versatile Du Pont "Mylar" polyester film, used alone or in combination with other materials, is making possible superior performance for a variety of electrical products.

For more information on how "Mylar" can help you improve product performance, or solve knotty problems, send in the coupon below. Be sure to indicate the type of application you have in mind.

** Mylar is a registered Du Pont trademark for its brand of polyester film.*

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

DU PONT **MYLAR®** POLYESTER FILM

E. I. du Pont de Nemours & Co. (Inc.)
Film Dept., Room E-4, Nemours Bldg., Wilmington 98, Del.

Please send the new booklet (MB-4) listing properties, applications and types of "Mylar" available.

Application _____

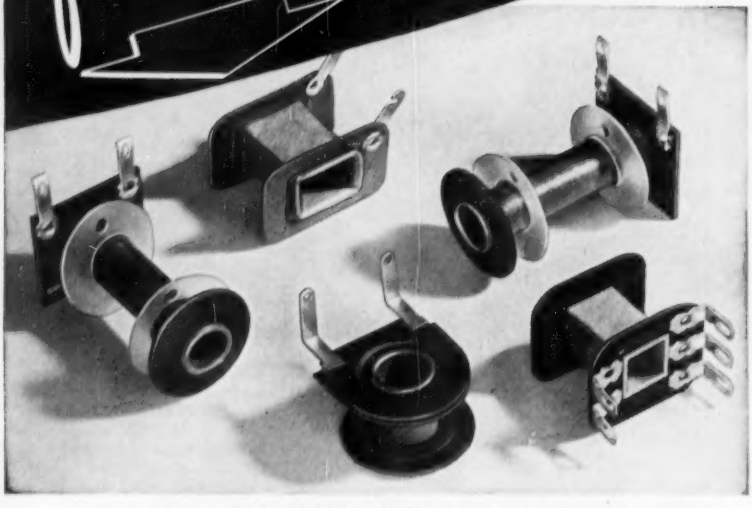
Name _____

Company _____

Address _____

City _____ State _____

Here is the IDEAL COIL BOBBIN for Printed Circuits



● *FURNISHED WITH ANY NUMBER OF LUGS ATTACHED AT A NEW LOW IN UNIT COST*

Low-cost coil bobbins can now be furnished to your specifications with any number of lugs attached. Through the development of special high production automatic equipment, Precision has eliminated the expense and difficulty of attaching terminals... especially as encountered with molded type bobbins.

The attached lug feature especially adapts these bobbins to printed circuit applications. Equally important, they can be insulated from the coil winding by washers as an integral part of the assembly. This latter advantage not only improves insulation, but greatly facilitates easier and faster production of the finished coil.

Coil bobbins with lugs attached are available in any size . . . with round, square or rectangular cores . . . flanges of all shapes. Cores are wound from dielectric kraft, fish paper, acetate or combinations, including DuPont Mylar. They can also be supplied Resinite impregnated.

Write, wire or phone for full information

Sales Representatives in:

Illinois; Indiana; Iowa; Wisconsin; Missouri; Minnesota: Chicago, Illinois, ARmitage 6-5200.
Indiana; Southern Ohio: Logansport, Indiana, Logansport 2555.
Northern Ohio: Cleveland, Ohio, ATlantic 1-1060.
New England: Framingham, Massachusetts, TRinity 3-7091.
Delaware; Washington, D. C.; Maryland; New Jersey; Metropolitan New York; Eastern Pennsylvania; Virginia: Jersey City, New Jersey, Swarthmore 5-2480.
Upper New York: Syracuse, New York, Syracuse 4-2141.
CANADA: Montreal, Quebec, Canada, Walnut 0337.
MEXICO: Mexico 6, D. F., Telephone: 35-06-18.

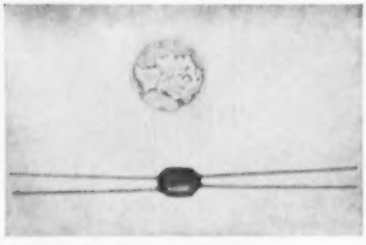
PRECISION

PRECISION PAPER TUBE CO.

2041 W. CHARLESTON ST. • CHICAGO 47, ILL.
Plant No. 2: 79 Chapel St., Hartford, Conn.

quality performance of operation in high altitude servo systems. As such, it complies with MIL-E-5400 requirements. A 3-legged transformer acts as a combined power supply and output transformer in the reluctance amplifier circuit.

▶**Other Features** — With instantaneous response the 1124 accepts a single d-c input or takes the difference between two such inputs and a built-in 400-cycle synchronous chopper modulates the d-c signal to an a-c signal. It will drive any 115 v 400-cycle servo motor rated at 8 w or less. The present model features a voltage gain of approximately 25,000 (rms v out/d-c v in).



VOLTAGE DIVIDER
tiny, 3-section d-c type

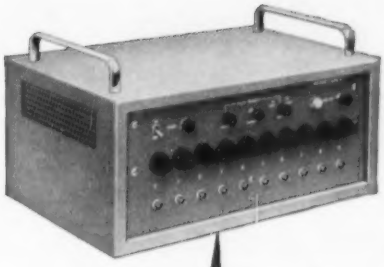
THE DAVEN CO., 530 West Mt. Pleasant Ave., Route 10, Livingston, N. J., has available a new, miniature, 3-section d-c voltage divider. Composed of three resistance sections with four output terminals, this unit is completely encapsulated, providing protection against saltwater immersion, and extremes of humidity and temperature (−55 C to +125 C).

▶**Specifications**—Measuring ¼ in. in diameter by ⅜ in. in length, the voltage divider is available with a maximum of up to 100,000 ohms per section. Standard resistor accuracy is ±0.5 percent. Wattage dissipation is ½ w at room temperature and 0.25 w at 125 C.

SMALL RELAY
for control circuits

KURMAN ELECTRIC CO., INC., 35-18 37th St., Long Island City, N. Y., has manufactured a new miniature telephone relay, designed for motor control, mobile radio and many other control circuits where there

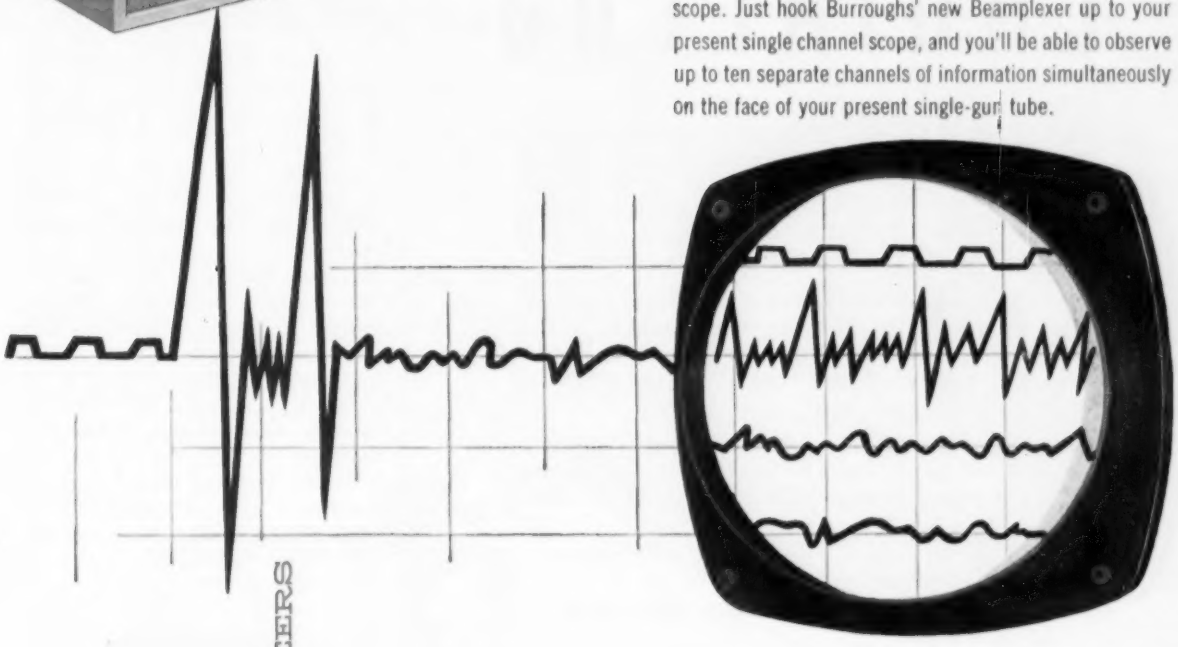
make your scope multi-channel



NEW BURROUGHS BEAMPLEXER

displays up to 10 separate signals on a single-channel scope simultaneously

Now you can have the advantages of multi-channel oscillography at a fraction of the cost of a multi-channel oscilloscope. Just hook Burroughs' new Beamplexer up to your present single channel scope, and you'll be able to observe up to ten separate channels of information simultaneously on the face of your present single-gun tube.



TOOLS FOR ENGINEERS

The Beamplexer is actually a fast electronic switch. Its heart is the Burroughs Beam Switching Tube which acts as a gate, picking the ten parallel input signals off in sequence, at adjustable speeds ranging from push button to 100 kc, and putting them out on one line. Each signal can be located on the scope as desired, and even superimposed on another, through individual position and amplitude controls for each channel. Other controls include separate amplification for each channel.

Power consumption is 120 volts a-c, 60 cps, single phase, 0.73 amps, with the entire unit self-contained for cabinet or standard relay rack mounting.

Full details on how the Beamplexer can make your scope more useful . . . make your time more efficient . . . are given in Technical Bulletin 346 available for the asking. Write for your copy.

Burroughs

BURROUGHS CORP. • ELECTRONIC INSTRUMENTS DIVISION
Department C • 1209 Vine Street • Philadelphia 7, Penna.

HPB 48-103

ELECTRONICS ENGINEERS

Link Aviation, Inc., one of the world's leading manufacturers of analog computing equipment, has built over $100 million worth of computer-actuated devices in the past five years. Most of this electronic computing equipment has been custom-designed to meet the highly specialized requirements of complex military training devices.

Our development activity embodies the fields of flight and radar simulators, missile and gunnery trainers, special purpose computers for laboratory and industrial applications, electronic laboratory instrumentation and specialized optical devices.

In a recently established program to develop top-flight technical men for management positions, we are seeking electronics engineers with the following qualifications:

1. Advanced degree in E. E., Engineering Physics or Applied Science.

2. One or two years' experience since attainment of advanced degree.

3. Training, experience, and interest in feedback systems, analog computation, vacuum tube or transistor circuitry (with particular emphasis on low-frequency or instrumentation applications), instrument servomechanisms.

The men we seek are making rapid progress in their present jobs, but are interested in greater opportunities unrestricted by age, seniority, rigid salary structures, formalized tables of organization, and other administrative obstacles. Our high order of dependence upon key technical men creates a challenging opportunity for superior engineers which we feel is unusually attractive.

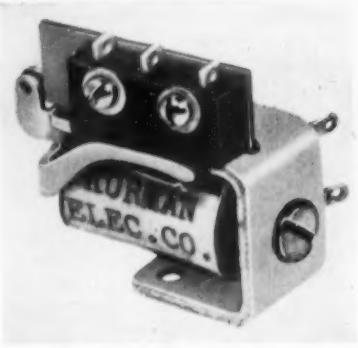
Please send full details of your qualifications to:
MR. JOHN M. HUNT, Manager of Engineering

LINK AVIATION, INC.

LINK AVIATION, INC., BINGHAMTON, N. Y.

PIONEER AND WORLD'S LARGEST PRODUCER OF JET FLIGHT SIMULATORS

A subsidiary of General Precision Equipment Corp.



is need for a small relay to handle heavy currents of up to 5 amperes —125 v a-c.

The 7MS relay is $\frac{11}{16}$ in. by $1\frac{3}{8}$ in. by $1\frac{31}{32}$ in. high and has a life of 100,000 operations minimum under the contact load mentioned, with increased life under lesser load. A fast acting d-c relay with 100-mw minimum operating power, maximum coil dissipation of 1.5 w and maximum coil resistance of 6,000 ohms, it will meet MIL-R-5757B class A. Enclosed snap-action contacts are UL approved.

Special features include impregnation and tropicalization, hermetic sealing, replaceable switch assembly and a-c operation.

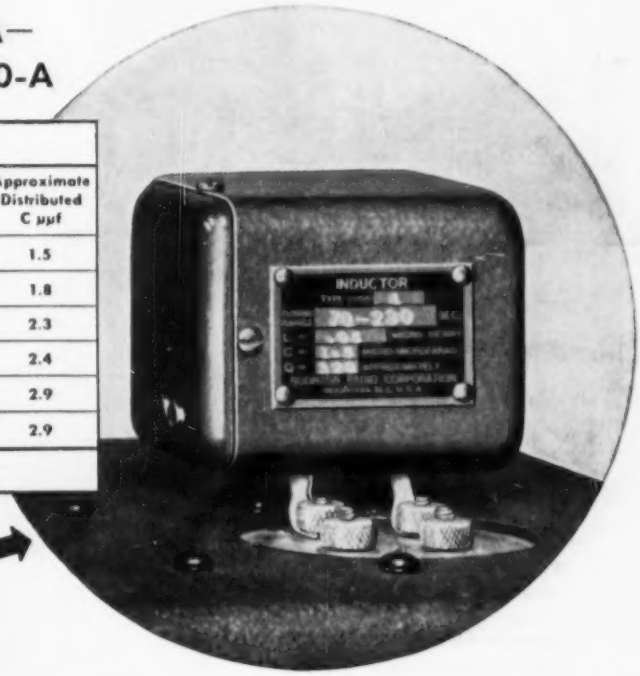
MAGNETIC AMPLIFIER
is voltage regulated

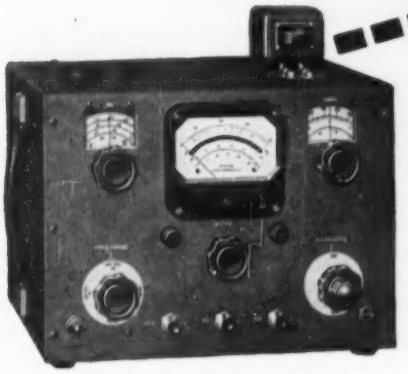
RAPID ELECTRIC CO., 2881 Middletown Road, New York 61, N. Y. A regulated 14/28 v, 200/100 ampere d-c power rectifier is designed to meet Air Force specifications MIL-P-8194 and MIL-P-6457A. Operating on 220/440 v, 3 phase, 50-60 cycles, the output voltage

Q Meter Inductors for measurements up to 260 mc!

INDUCTORS Type 590-A— accessories to Q Meter Type 190-A

TYPE 590-A INDUCTORS					
Type	Inductance μh	Capacitance μμf	Approximate Resonant Freq. mc	Approximate Q	Approximate Distributed C μμf
590-A1	0.05	8.0 — 95.0	70 — 230	320	1.5
590-A2	0.1	10 — 100	50 — 160	350	1.8
590-A3	0.25	8.0 — 80.0	30 — 100	310	2.3
590-A4	0.5	7.5 — 80.0	25 — 70	340	2.4
590-A5	1.0	7.5 — 65.0	20 — 50	300	2.9
590-A6	2.5	9.0 — 25.0	20 — 30	300	2.9
PRICE: $10.00 each F.O.B. BOONTON, N. J.					





Q METER Type 190-A

This new 190-A Q Meter measures an essential figure of merit of fundamental components to better overall accuracy than has been previously possible. The VTVM, which measures the Q voltage at resonance, has a higher impedance. Loading of the test component by the Q Meter and the minimum capacitance and inductance have been kept very low.

SPECIFICATIONS—TYPE 190-A

FREQUENCY RANGE: 20 mc. to 260 mc.

RANGE OF Q MEASUREMENT:

Q indicating voltmeter	50 to 400
Low Q scale	10 to 100
Multiply Q scale	0.5 to 3.0
Differential Q scale	0 to 100
Total Q indicating range	5 to 1200

PERFORMANCE CHARACTERISTICS OF INTERNAL RESONATING CAPACITANCE: Range—7.5 mmfd. to 100 mmfd. (direct reading).

POWER SUPPLY: 90-130 volts — 60 cps (internally regulated).

Type 190-A Price: $625.00 F.O.B. Factory

Inductors Type 590-A are designed specifically for use in the Q Circuit of the Q Meters Type 170-A and 190-A for measuring the radio-frequency characteristics of condensers, resistors, and insulating materials. They have general usefulness as reference coils and may also be used for periodic checks to indicate any considerable change in the performance of the Q Meters.

Each inductor Type 590-A consists of a high Q coil mounted in a shield and is provided with spade lugs for connection to the coil terminals of the Q Meters. The shield is connected to the lugs which connect to the Low Coil terminal in order to minimize any changes in characteristics caused by stray coupling to elements or to ground.

BOONTON RADIO Corporation
BOONTON · N·J · U·S·A ·

Want more information? Use post card on last page.

Technical assistants

for **ELECTRON TUBES**

The Electron Tube Laboratory is engaged in research and development in the fields of direct-viewing storage tubes and microwave tubes. The personnel comprises men with many years' experience in the field of electron tubes and their applications.

Very new developments in microwave and display tubes have created a number of openings at the research and development level for Laboratory Assistants. At Hughes, engineers, scientists and technicians develop their ideas from inception to quantity production. Thus, assistants working with electron tube products have unlimited scope for applying their talents and skills to a wide range of military and commercial uses.

You should qualify in any **3** *of the following areas:*

Electron Circuitry and Test Equipment Construction
Mechanics and Benchwork Skills
Tube Fabrication Techniques
High Vacuum Techniques
Microwave Testing
Tube Chemistry
Precision Assembly

SCIENTIFIC STAFF RELATIONS

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

regulation from no load to full load is held within 0.5 v, including a variation of ± 10 percent of the rated input voltage.

▶ **Maintenance** — Periodic air-cleaning of selenium rectifier stacks is all the maintenance required. Self-lubricating fan-motor bearings eliminates lubrication.

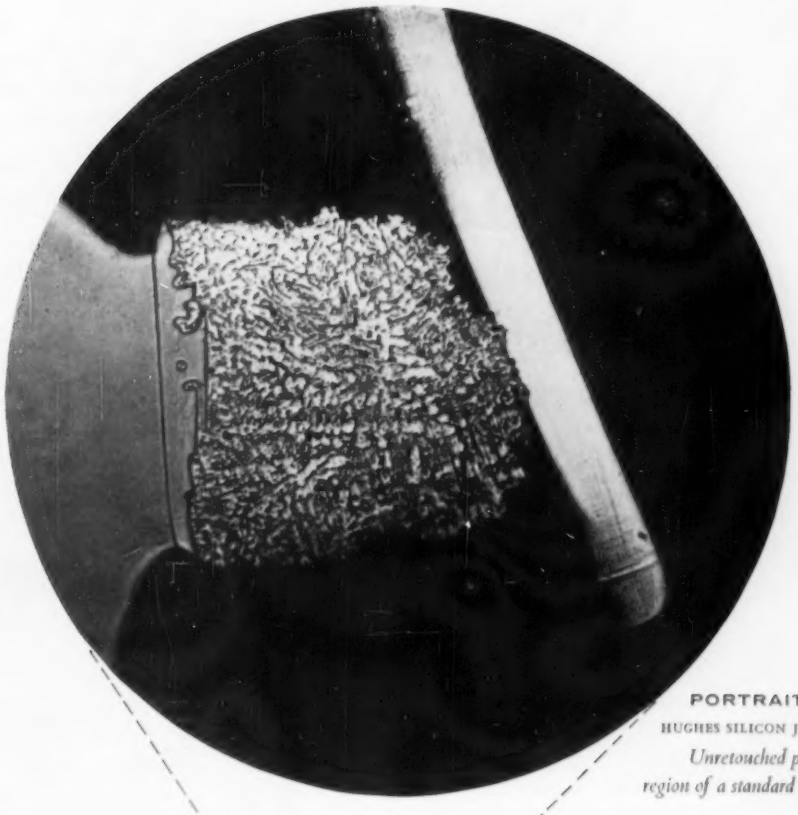
SHF WAVEMETER
covers 4,000 to 10,000 mc

MARCONI INSTRUMENTS, 44 New St., New York 4, N. Y. The TF1059 shf wavemeter covers the wide band of 4,000 to 10,000 mc by use of a cavity resonator operating in a hybrid mode. It is tuned by a 2½ in. precision micrometer and is totally enclosed, the micrometer being viewed via a low power lens.

▶ **Highlights** — Its features are high Q and an accuracy of 0.05 percent. Discrimination at the worst point is 0.03 percent. Power required is 1 mw.

PILOT LIGHTS
with spade terminals

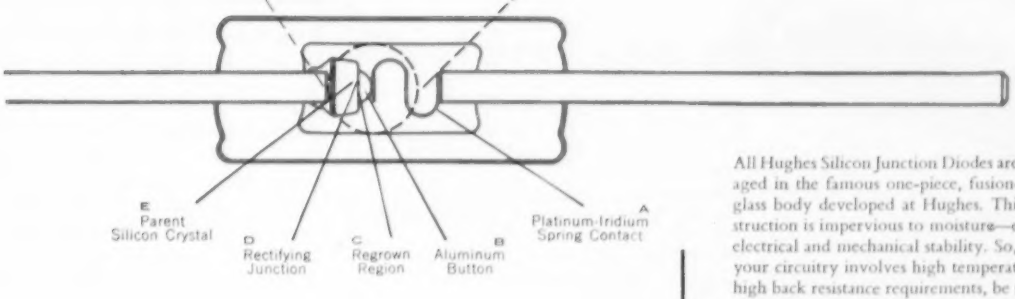
DIALIGHT CORP., 60 Stewart Ave., Brooklyn 37, N. Y., now offers its series of indicator lights, which accommodate bayonet type miniature lamps, with spade terminals. These terminals are the matching male



PORTRAIT OF RELIABILITY

HUGHES SILICON JUNCTION DIODES

Unretouched photomicrograph of the junction region of a standard Hughes Silicon Junction Diode.



RELIABILITY YOU CAN SEE

In this cross section (made from a standard, non-selected production specimen), renowned Hughes quality is clearly visible. (A) The platinum-iridium whisker makes firm, positive contact with the aluminum button. (D) The rectifying junction is clean, sharp, and straight. (E) The parent silicon crystal is free from strain-induced cracks, fissures or blemishes around the junction. Such meticulous workmanship gives microscopic evidence that, in semiconductors, HUGHES QUALITY *means* HIGHEST QUALITY.

**Characteristics rated at 25° C and at 150° C. Ambient operating range, —80° C to +200° C.*

Actual size

***Dimensions, diode glass body: 0.265-inch by 0.105-inch, maximum.*

All Hughes Silicon Junction Diodes are packaged in the famous one-piece, fusion-sealed glass body developed at Hughes. This construction is impervious to moisture—ensures electrical and mechanical stability. So, when your circuitry involves high temperature or high back resistance requirements, be sure to specify *Hughes* Silicon Junction Diodes. Available now, at lower prices, in nine different standard and several special types. And, as always, they are First Of All . . . For RELIABILITY!

FEATURES:

*High Temperature Operation**
Extremely High Back Resistance
Very Sharp Back Voltage Breakdown
Excellent Forward Conductance
*Subminiature Size***
Exceptionally Stable Characteristics

For descriptive product information, please write:

HUGHES

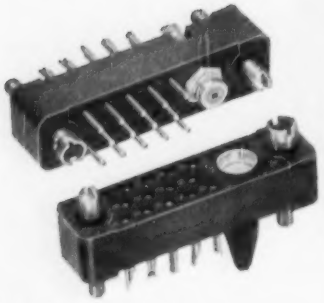
SEMICONDUCTORS
HUGHES PRODUCTS
International Airport Station
Los Angeles 45, California

HUGHES PRODUCTS

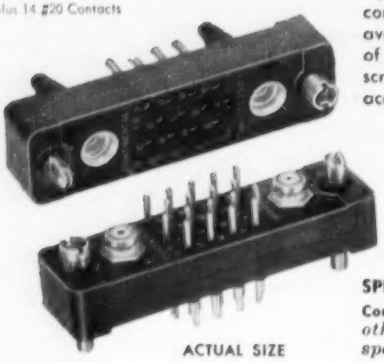
A DIVISION OF THE HUGHES AIRCRAFT COMPANY

© 1956, H.A.C.

Continental Connectors
adds coaxial contacts to series "20" miniature connectors



Single Coax Contact plus 14 #20 Contacts



ACTUAL SIZE

2 Coax Contacts plus 14 #20 Contacts

Now you can specify a connector that combines 50-ohm matched impedance coaxial contacts in a special insert arrangement with standard pin contacts for #20 AWG wire. Design is particularly adaptable to miniaturized equipment requiring extremely compact components. "Series 20" is available with coax contacts, a variety of pin arrangements, plus polarizing screwlocks* to protect against accidental disconnection.

SPECIFICATIONS:

Contacts: *14 and 18 (as illustrated) plus other contacts and arrangements on special order.*

Contact Pins (brass) and Sockets (spring temper phosphor bronze) silver and gold plated for low contact resistance.

Terminals: *Solder cup or turret type.*

Moldings: *Choice of Mineral-filled Melamine, Plaskon reinforced (glass) Alkyd 440A, or Orlon-filled Diallyl Phthalate.*

ELECTRICAL RATINGS:

Voltage Breakdown:
At Sea Level.....2100 Volts RMS
At 60,000 Ft.....750 Volts RMS
Current Rating .....5 Amps.

Additional information on these connectors, and special designs requiring the use of subminiature, printed circuit, hermetic seal, pressurized, high voltage, or power connectors are available on request. Write today for free catalog.

you're sure with

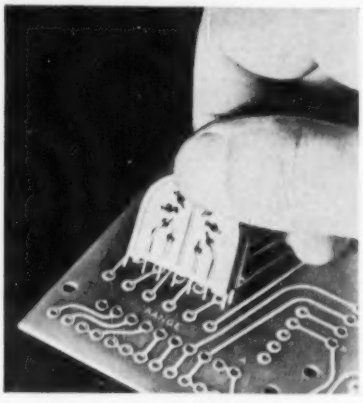
DeJUR

ELECTRONIC SALES DIVISION
DeJUR-Amsco Corporation
45-01 Northern Blvd.
Long Island City 1, N. Y.

*Pat. Pending

part for the convenient quick-connect type wire terminals. The connection is positive with triple spring action and, in many situations, their use makes a cost-saving contribution to the manufacture or maintenance of equipment.

The T-3¼ incandescent bulbs which are used may be had in 2 to 55-v ratings. With Dialco's built-in resistor these pilot lights may be used on voltages of 105-125 v or 210-250 v. Simple external resistors can be provided for all higher voltages.



RIGHT-ANGLE SOCKETS for printed wiring

AEROVOX CORP., Pacific Coast Division, 2724 South Peck St., Monrovia, Calif., has announced right-angle tube sockets that provide marked reduction in height and depth of printed-wiring assemblies. They are equally adaptable to hand-or machine-insertion methods. Terminals are of adequate length to slip into printed wiring holes and be dip soldered. Silver-plated contacts are engineered to provide nonfatiguing contact pressure with suitable insertion and withdrawal pressures. Metal parts and mounting hardware are plated to meet salt-spray test specifications.

▶ **Four Types**—These components are available in 7- and 9-pin sockets and in 4 different versions. Type A is for general-purpose applications where extra rigidity and resistance to vibration and shock are not important factors; type AX, for special applications requiring extra rigidity; type B, same as A, but with tube shield added; and type

TAYLOR Shop Talk

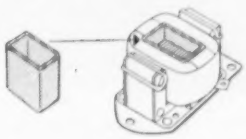
Laminated Plastics
Vulcanized Fibre

TAYLOR FIBRE CO.
Plants in Norristown, Pa. and La Verne, Calif.

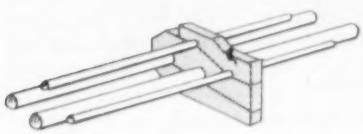
PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

Tips for designers

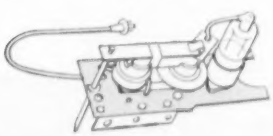
Terminal strips for high-precision electronic instruments benefit from the excellent insulating properties of Taylor XXXP-301 hot-punch laminate.



Coil forms for this solenoid have to operate at high temperatures . . . an ideal application for Taylor glass melamine laminate.



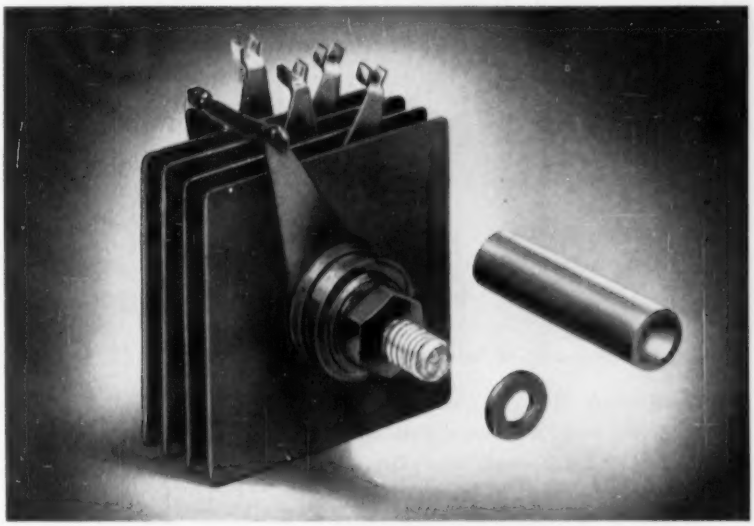
Fuel line clamp for a fighter airplane's "pipe-line" system is machined from Taylor fabric base laminate which has high mechanical strength and resists extreme temperature and humidity.



Base plate for high-voltage TV component, punched from Taylor canvas melamine laminate, has high dielectric strength and arc resistance.

TAYLOR FABRICATING FACILITIES

Your production problems can often be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts of vulcanized fibre and laminates to your specifications. Efficient, modern facilities are ready to serve you. Write to Taylor about your specific requirements.



Low-flow under physical load is an important characteristic of the Taylor Grade 353 washer used in this selenium rectifier. The Taylor Grade XX-10 tube provides dependable, long-lasting insulation for the current-carrying plates.

Electrical and physical stability *recommend Taylor laminates*

Dozens of different grades of Taylor laminates offer the designer and the production man a variety of combinations of electrical and physical properties for a wide range of product applications.

And very important . . . but often overlooked . . . is the degree to which these Taylor laminates maintain their original characteristics, over long periods of time and under severe operating conditions. You can have performance to fit your requirements . . . performance with stability . . . when you use Taylor laminates.

Included in this broad selection of materials are paper, fabric and glass bases . . . phenol, melamine, silicone and epoxy resins. Within the complete line there is the combination you need, to improve the performance of your present product or to help move a new product into practical and economical production.

They are available in several forms, too, which make for greater fabrication efficiency . . . sheets 49″ by 49″, and tubes and rods in a wide range of sizes.

Whenever you are looking for a laminate . . . and particularly when the specifications include stability . . . it will pay you to check with Taylor first. To help you in your selection, Taylor offers the services of its engineering staff as well as the facilities of its fabricating division. Call on Taylor for a consultation on your specific requirements.

Want more information? Use post card on last page.

UNIQUE SENSITIVE RELAY

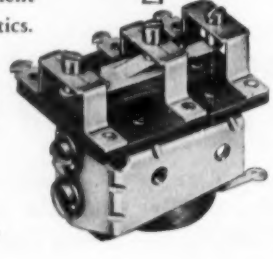
incredibly small, lightweight and adjustable!

ADVANCE "SO" SERIES

Here for the first time is a sensitive relay only 1-7/32"x 1-1/8"x 1-1/4"... weighing only 1-1/2 ounces, and adjustable over a wide range. You get much more latitude with this relay in designing for tiny areas.

The Advance "SO" is set at the factory to operate on 10 milliwatts. User can adjust it down to 2 milliwatts, or any desired pick-up or drop-out, by means of fine screw contacts. A balanced armature provides extremely sensitive operation. The unit is highly efficient, ruggedly built, and offers excellent shock and vibration-resistant characteristics.

Contact arrangement is SPDT. Coil resistances: 4000, 6500 and 10,000 ohms. Life expectancy: 250,000 operations. Available in open types... dust-tight or hermetically sealed enclosures. Now in quantity production. Advance "SO" relays are priced amazingly low. Write for literature.



Coil Resistance	Pick Up Voltage	Pick Up Current	Drop Out Voltage	Drop Out Current	Max. Coil Voltage for Continuous Duty	Overtravel	Contact Gap
4000	6.4 V	1.6 MA	3.2 V	.8 MA	110 V	.0015	.002/.003
6500	8.1 V	1.25 MA	3.9 V	.6 MA	140 V	.0015	.002/.003
10,000	10 V	1 MA	5 V	.5 MA	175 V	.0015	.002/.003

ELECTRONICS DIVISION

ELGIN NATIONAL WATCH COMPANY

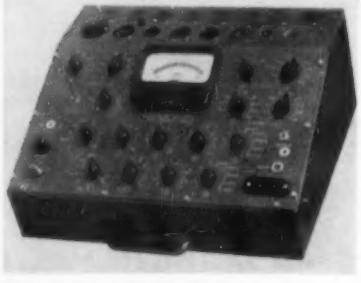
FOR RELAYS: 2435 N. Naomi Street, Burbank, California

BX, same as AX, but with tube shield added.

POWER METER
d-c to 500 mc

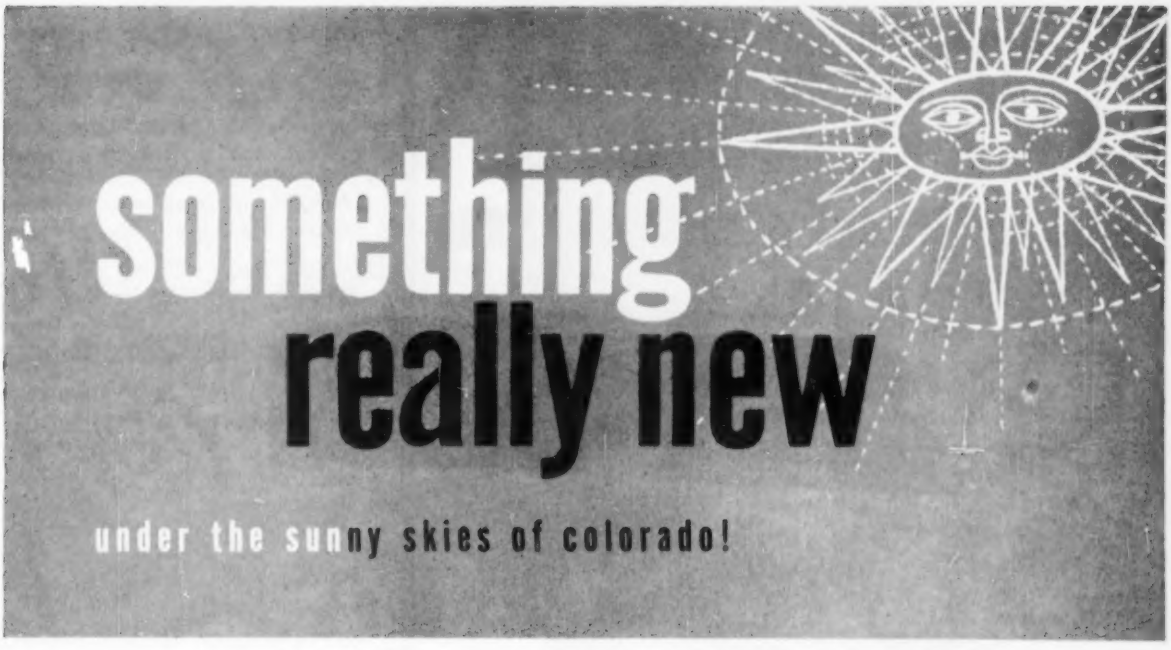
MARCONI INSTRUMENTS, 44 New St., New York 4, N. Y. The TF-1152/1 measures true power from d-c to 500 mc with an accuracy of 5 percent up to 250 mc. It has ranges of 10 and 25 w maximum and a parallel-plate line matched to the cracked carbon load resistor insures a pure input impedance of 50 ohms throughout its entire frequency range.

Since it reads true power, modulation depth can be easily calculated. Calibration can be readily checked at d-c or 60 cps.



TUBE CHECKER
checks international types

AMERICAN METRIX CORP., Box 179, Upper Darby, Pa., The type 310 will rapidly make a series of checks and measurements on receiving tubes, at one of several points on the static characteristic chart, in conditions similar to normal working conditions. It checks filament con-



A NEW Division of The Glenn L. Martin Company

A NEW engineering project

A NEW technical challenge

A REALLY new way of life for engineers and scientists in the wonderland of Colorful Colorado

DENVER, the capitol of Colorado, is the site of Martin's new multi-million dollar plant where development work has begun in new fields of engineering. To enhance this project, Martin is offering the finest in laboratory and production facilities; salary levels commensurate with experience and ability; association with people of extremely high technical competence; opportunities of advancing oneself professionally . . .

PLUS, a higher standard of living . . . and a way of life that is unhurried, stimulating, and completely enjoyable.
The Glenn L. Martin Company's NEW DENVER DIVISION in the heart of the Colorful Colorado Rockies will put you on the threshold of a career that has no limit.
We invite you to inquire about positions now open in the following fields:

POSITIONS:

Circuit Design & Anal.	Servo Design
Auto. computations	Instrumentation
Mathematicians	Physicists
Electronics Engineering	Electronic Systems
Systems Analysis	Communications

MARTIN
DENVER DIVISION

Address inquiries to: Emmett E. Hearn, Employment Director, Box 179, Dept. H, Denver, Colorado

Want more information? Use post card on last page.

ALL NEW DESIGN!

Simple...Foolproof...Low Cost

1500 WATT HOMELITE GENERATOR

Model 35A115
Homelite Generator
1500 Watts, 115 Volt
60 Cycle AC
90 Pounds

1. New Money-Saving features . . . No DC brushes; just two easy-to-get-at collector ring brushes . . . No commutator or DC windings . . . No intermediate couplings; armature keys directly to shaft. Fewer parts to wear out — longer trouble-free generator service.

2. Constant Voltage . . . less than 4% change from no load to full 1500 watt capacity . . . assures long service life for your electrical requirements . . . guarantees top performance at all times.

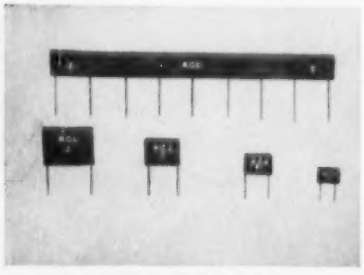
3. Overload Capacity . . . 1500 watt continuous duty with generous overload capacity prevents stalling under heavy loads . . . insures uninterrupted service even when starting loads exceed operating loads.

4. Compact and Lightweight . . . one man can easily carry this generator wherever you need electricity to power time-saving electronic and communications equipment. No need for long, hazardous power-consuming cables.

SAVE EVEN MORE!
New Homelite idle control unit, available as optional accessory, runs engine at idle speed when no current is drawn . . . automatically brings engine to full speed when load is applied.

HOMELITE
A DIVISION OF TEXTRON AMERICAN, INC.
6804 RIVERDALE AVE., PORT CHESTER, N.Y.
Manufacturers of Carryable PUMPS
GENERATORS • BLOWERS • CHAIN SAWS

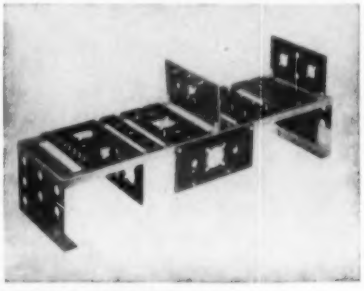
tinuity, hot and cold interelectrode short circuits, and filament-cathode insulation, and will measure plate current and mutual conductance anywhere on the characteristic chart. An overload cutout protects the instrument against faulty usage.



PRECISION RESISTORS
encapsulated, wire-wound

R. C. L. MFG. CO., P. O. Box No. 25, Riverside, N. J. Series 3030 encapsulated wire-wound precision miniature and subminiature resistors are designed and built to withstand wide temperature ranges with ambients up to 125 C, humidity, salt water immersion, corrosion and shock without deterioration. They will withstand all test requirements of MIL-R-93; and can be supplied in radial and axial lead styles.

▶ **Technical Information** — Standard tolerances are 1 percent, available to 0.05 percent. Temperature ranges are −70 C to +125 C. Wattage is 0.1 to 0.750 w. Range is from 1 ohm to several megohms.

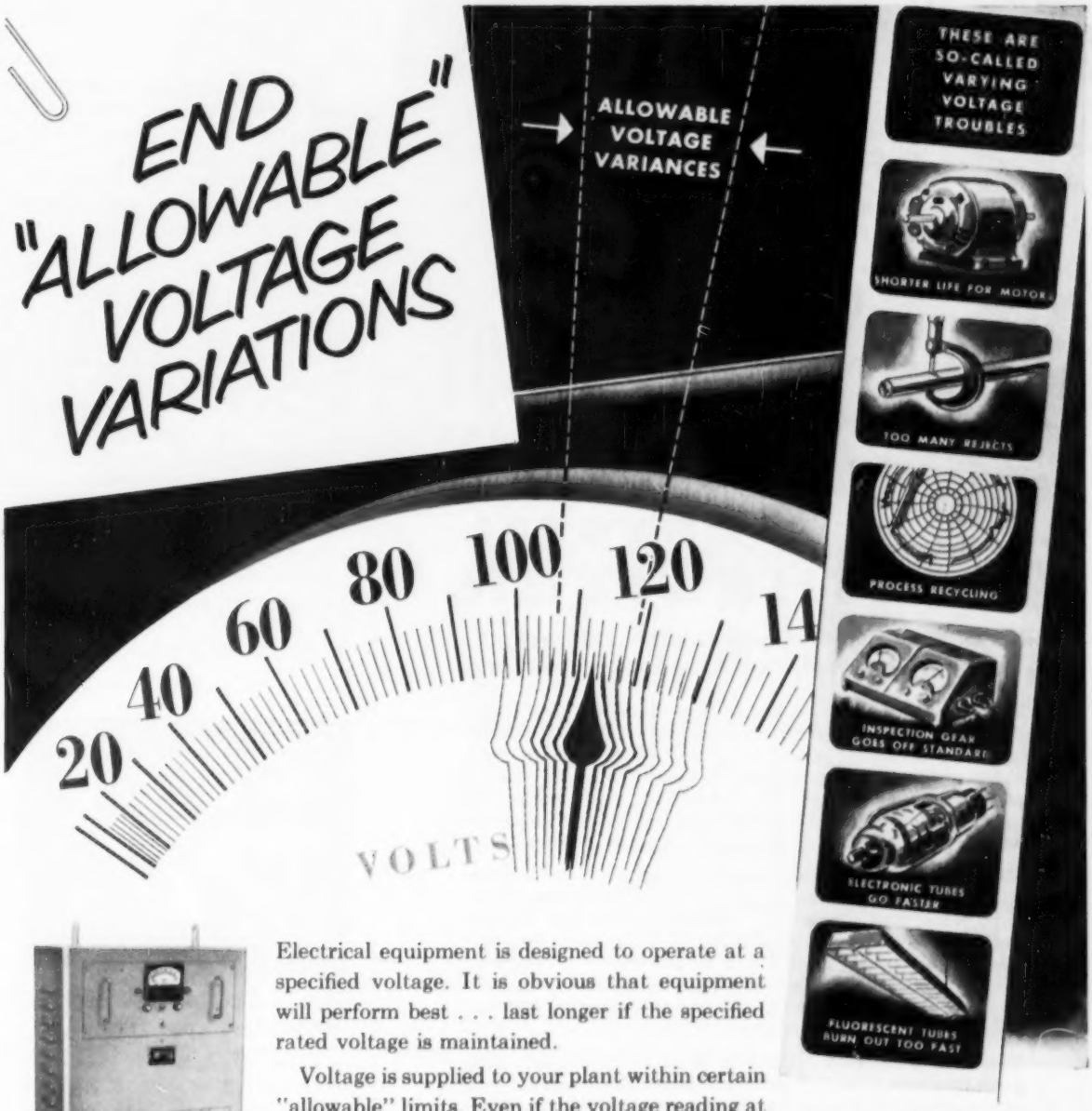


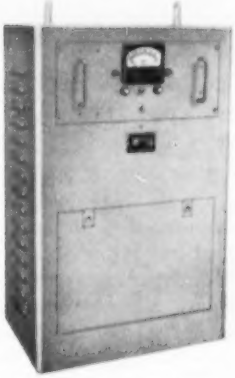
CHASSIS KIT
for prototype models

PRECISION METAL PRODUCTS CO., 41 Elm St., Stoneham 80, Mass. The 3-D chassis kit is designed to provide complete flexibility to the design and development engineer in the construction of prototype mod-

For additional information on all items on this page, use post card on last page.

END "ALLOWABLE" VOLTAGE VARIATIONS





STABILINE type EM6220Y

Electrical equipment is designed to operate at a specified voltage. It is obvious that equipment will perform best . . . last longer if the specified rated voltage is maintained.

Voltage is supplied to your plant within certain "allowable" limits. Even if the voltage reading at your doorstep is right on the button, voltage variations occur within the plant.

STABILINE* Automatic Voltage Regulators end voltage variation headaches. They maintain constant specified voltage to voltage-sensitive equipment regardless of line voltage fluctuations or load changes. There is a STABILINE to fulfill the needs of most applications. Let us give you more facts.

*Trade Mark Reg. U. S. Pat. Off.

14663 Titus St., Van Nuys, Cal. • P.O. Box 946, 2881 El Camino Real, Redwood City, Cal. 482-B Eglinton Ave., West, Toronto 12, Ontario, Can. • 2217 Biscayne Blvd., Miami 37, Florida • P.O. Box 48, 721 So. Blvd., Oak Park, Ill. • 4033 W. Rogers Ave., Office #2 Tippett Bldg., Baltimore 15, Maryland • 250 Park Ave., Rms. 502-504 Postum Bldg., New York 17, N. Y. • P.O. Box 132, 101 Public Sq., Medina, Ohio • 4515 Prentice St., Room 201, Dallas 6, Texas.

THE SUPERIOR ELECTRIC COMPANY

THE SUPERIOR ELECTRIC COMPANY
204 MIDDLE ST., BRISTOL, CONNECTICUT

Have your representative call ☐
Send STABILINE Bulletin S351 ☐

Name.....
Company Name.....
Company Address.....
City.....*Zone*...*State*.....

Want more information? Use post card on last page.

A Long Step FORWARD in—

PRECISION
FREQUENCY
SYNTHESIS...

the
MANSON
Series 182

CRYSTAL
SYNTHESIZER

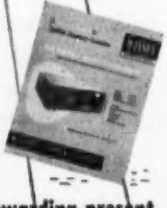
★ STABILITY . . . 1 in 10^7 ★ RESETABILITY . . . zero error
★ READABILITY . . . zero error ★ SPURIOUS SIGNALS . . . down 80 db

20,000 precisely-selectable, exact frequencies are at your fingertips in this disciplined incremental oscillator. It is the black-box equivalent of 20,000 crystals . . . and offers setability, readability and stability approaching the theoretical limits. Unskilled personnel can take immediate advantage of its designed-in simplicity, versatility and precision, and it meets JAN Specifications for electrical, mechanical and environmental performance.

PULL-IN and **HOLD-IN** are equal and automatic through a new Discriminator* without moving parts . . . **DIGITIZED DIAL*** gives direct readings of frequency . . . **READOUTS** are both mechanical and electrical . . . **AUTOMATIC RESET** to exact frequency after power failure . . . **REMOTE OPERATION** * available . . . **ALL-ELECTRONIC** design with simplified circuitry and construction for fast, easy maintenance . . . and many other unique features.
*Patents Applied For.

Three Models cover the range from 18 mc to 410 mc, with increments providing from 2000 to 20,000 discrete frequencies in each portion: Model **182-A** for the **HF** spectrum — **182-B** for **VHF** — and **182-C** for **UHF**. The Manson Series 182 Crystal Synthesizers are outstanding for use as:

Transmitter Exciters — Frequency Standards — Ultra-Stable Signal Generators and Frequency Meters—Low-Power AM and FM Transmitters—and as Master and Beat-Frequency Oscillators with Double and Single Side-Band Receivers.



.....Write for Bulletin 182

Manson offers to Engineers and Technicians a rewarding present and attractive future in suburban Connecticut.

MANSON LABORATORIES
207 Greenwich Avenue
DAvis 4-6739
STAMFORD • CONNECTICUT
Design and Production of Specialized Electronic Equipments

els. It consists of: end brackets, side channels, terminal strips, miniature and octal tube socket plates, component mounting boards, mounting brackets, double-end press-in terminals, self-tapping screws, potentiometer mounting boards, and rack mounting plates.

▶ **Materials Used**—Plastic used in all mounting boards is laminated, paper base, XXXP (MIL-P-3115), type PBE. This material has low dielectric losses and excellent insulation resistance. Its $\frac{3}{32}$-in. thickness provides excellent strength. The silver-plated solder terminal lugs, type PMP No. 1602, are lacquered to prevent tarnishing.

Overall size of the chassis kit is 5 in. wide, $16\frac{7}{8}$ in. long and $3\frac{1}{2}$ in. high. Capacitors, controls and components are easily mounted through the many holes provided. Two or more kits may be joined together for more complex prototypes.

GLASS CLOTH BOBBINS
laminated silicone type

SILICONE INSULATION, INC., 567 Third Ave., New York 16, N. Y. A silicone glass cloth bobbin laminated into a unified structure is finding a most needed application in high-temperature transformers, solenoids, relays and other coil-using equipment. The new spool maintains both mechanical and dielectric strength at the joints.

The bobbins include round and rectangular units with two or more flanges, with irregular flanges, protrusions, core extensions, or metal inserts.

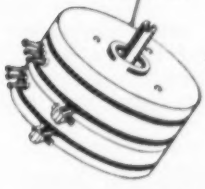
▶ **Thin Walls** — Their thin rigid walls save valuable winding space. Wall thickness of 0.030 in. are most frequent, but walls of 0.020 in. or 0.015 in. are common, while some

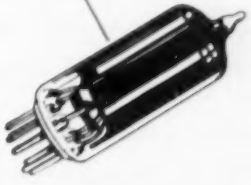
the best way to sell the 6.8-billion dollar electronic market is thru the . . .

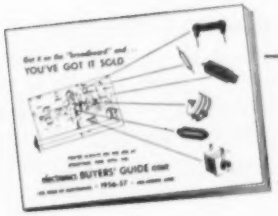
electronics BUYERS' GUIDE

For 15 years, purchasing influences have relied on the ELECTRONICS BUYERS' GUIDE to provide necessary product information at that important place, the point-of-purchase . . . the designers' board. An advertisement in the BUYERS' GUIDE will keep your product in front of these purchasing influences . . . all year 'round. This 13th issue of ELECTRONICS, used by more than 40,000 subscribers, provides accurate, complete product specifications and simple telephone-type listings (more than 2,200). It's the electronic industry's complete and preferred reference and source book.

Plan now for your ad in the 1956-57 mid-June BUYERS' GUIDE. *It's the sure way to get a share of the $6.8-billion electronic market.*







For the complete story on how the BUYERS' GUIDE can sell electronic components, equipment, materials . . . send for the free booklet titled: *GET IT ON THE "BREADBOARD" AND . . . YOU'VE GOT IT SOLD!*

electronics BUYERS' GUIDE

330 WEST 42ND STREET (ABP) A McGRAW-HILL PUBLICATION (ABC) NEW YORK 36, N. Y.

modernization

For the benefit of those to whom marking pulses and spacing pulses are only assorted bauds — the top illustration represents a venerable, familiar and respected telegraph relay made by one of the great corporations. For a long time it has been common in Teletype communication equipment; and, as with the DC-3 airplane, its "bugs" are pretty well domesticated.

Then, in a 1946 development contract, the Signal Corps asked for a small equivalent — hermetically sealed against the tropics and G. I. fingers. Ironically enough, when it came time to try and sell the result (Sigma Series 7) nobody had any way of using it unless it fitted existing sockets and cover clamps.

This led to the preposterous but effective arrangement in the second illustration.

There was only one trouble. It had been the custom with the predecessor relay to clean and adjust contacts at infrequent intervals during a long service life. Hermetic sealing, besides somewhat impairing contact life, makes service and adjustment quite impractical. (Some will recall previous mention of the Air Force Captain and his dramatic "small hole treatment." The story was true.) So the verdict on the Series 7 was confused: Good in "tactical" situations; i. e., foxholes; also good in some commercial equipment, but n. g. in other.

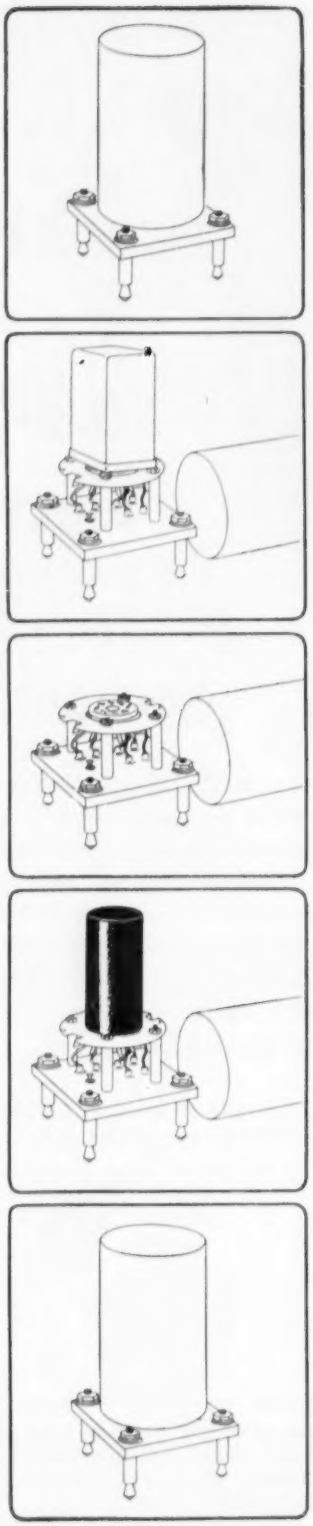
A private attempt to end all such attempts — with a *good* Sigma telegraph relay once and for all — led to the Series 72 . In order to be sure of *no* distortion at 100 word-per-minute speeds, it was made capable of acceptable behavior at 1000 w. p. m. Not only was it made with a detachable cover, but the wearing parts were made replaceable like phonograph needles. (It was our good fortune that the "72" turned out, in addition, to be a rather decent relay on a great many other counts, which means business outside the telegraph field.)

Now, of course, there may be some devil-may-care individuals actually designing future equipment of this type with octal sockets. The AB-37 Adaptor is still around, however, for those who must look before they leap.

SERIES 72
HIGH SPEED
RELAY

Outstanding Specifications

Pulse Relaying	500 per second at 75% efficiency
Life under Load	About 500 million operations without adjustment. (110 V 60 ma. DC simulated printer)
Maintenance	Bias, Sensitivity adjustable; contacts, armature easily replaceable
Vibration Immunity	15 g to 500 cps even unenergized



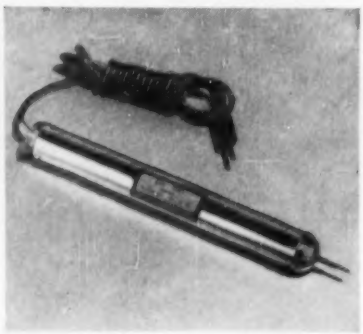
SIGMA

SIGMA INSTRUMENTS, INC., 62 Pearl Street, So. Braintree, Boston 85, Massachusetts

have been made as low as 0.010 in.

Close dimensional tolerances can be maintained—±0.005 in. is normal while ±0.001 in. is possible. These tolerances are largely a function of the tooling.

Laminated silicone glass cloth bobbins meet and exceed class H temperature requirements.



VOM PROBES
are rugged and accurate

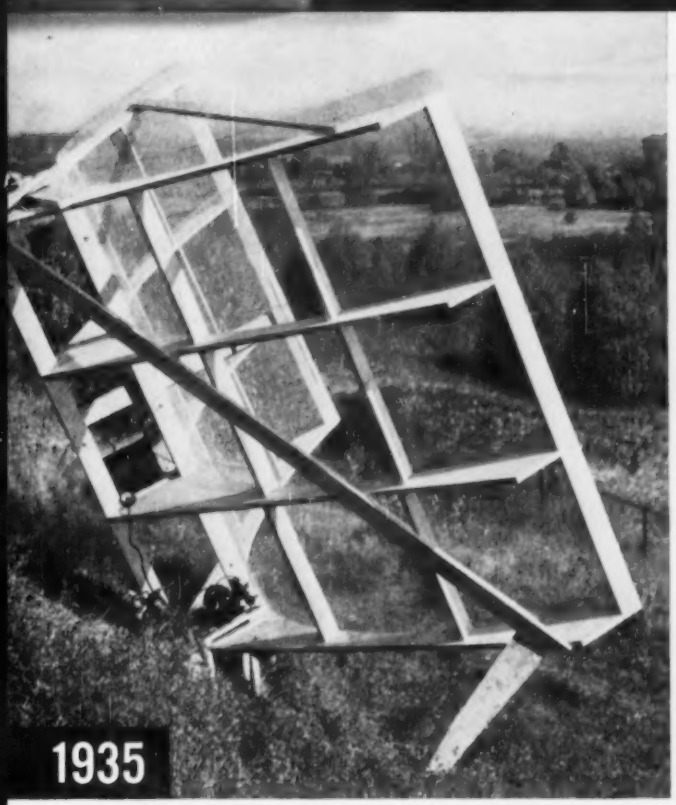
FUTURAMIC CO., 2500 W. 23rd St., Chicago, Ill. Model 261 high-ohms probe extends the ohmmeter range of the vom by a factor of 10. It permits measurement of resistance values up to 200 megohms. The probe can be used with any 20,000 ohms-per-volt vom having a center-scale indication of 12 ohms, and an internal ohmmeter battery of 7.5 v.

▶ **Other Features**—It is ruggedly constructed, highly accurate, and has a gold-plated steel housing with color-coded Lucite end pieces. The probe is put into operation by simply plugging into meter in place of conventional test load.

Price is $9.95.

R-F PREAMPLIFIER
features small size

APPLIED SCIENCE CORP. OF PRINCETON, P. O. Box 44, Princeton, N. J. Model APA-2 r-f preamplifier greatly improves the signal-to-noise ratio of a typical radio receiver in the 215-235 mc frequency band, resulting in a better reception of low-strength signals. Addition of the preamplifier to a typical receiving installation utilizing a receiver with a typical 10-db noise figure



EARLY RESEARCH AND DEVELOPMENT EXPERIENCE with electronic location equipment at G.E. began in 1935 when this first system, with an output of 1½ watts, located planes up to five miles away.

IN USE TODAY, this huge nodding height finder was designed and developed by General Electric to be used with powerful search radar systems and is a major contribution to long-range aircraft location.

How G.E.'s 20-year antenna background can help make your radar system more effective

6 examples show experience in all areas of land- and ship-based antenna work

To give you an outstanding source for reliable, precision radar antenna equipment, General Electric backs modern facilities with the know-how that comes from many years of research, engineering, and manufacturing experience.

For example, early research in electronic location equipment at G.E. began in 1935 and engineering and manufacturing experience includes these six major areas:

1. **Stabilized bases** to compensate for ship pitch and roll were built in large quantity with Navy antennas in World War II.
2. **Small, portable systems** for weather balloon tracking were developed and produced for the Army and Navy in 1948.
3. **Powerful heightfinding antenna,** FPS-6XW1, developed by G.E. for USAF in 1949, was an advancement in long-range detection.
4. **Giant shipboard search antenna,** largest in use today, was G-E developed and produced for Navy early-warning ships.
5. **Long-range search antennas** (FPS-7) were designed and built by G.E. using advanced construction techniques.
6. **One of the first combination antennas** (allows both search and elevation detection), the Navy's SPS-8 was designed and produced to give a precise beam pattern.

This extensive background enables clearer perception of special engineering and manufacturing problems. It is the element that helps give G-E precision antenna equipment the efficiency and reliability to help make your radar system more effective. For more information, contact your G-E Apparatus Sales Office or use coupon below.

Mail to: General Electric Company, Section F 223-2
Schenectady 5, N. Y.

Please send me these two bulletins:

GEA-6279, Radar Antennas, Mounts, Components, and Accessories

GED-2494, G.E.'s Naval Ordnance Department Offers Complete Engineering and Manufacturing Services

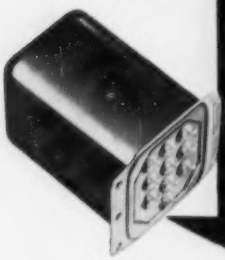
☐ **For immediate project.** ☐ **For reference only.**

Name . . . . . .
Position . . . . . .
Organization . . . . . .
Address . . . . . .

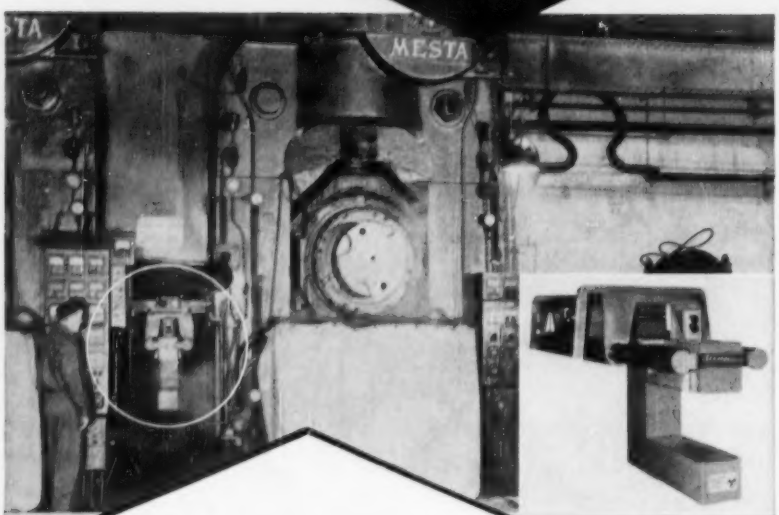
Progress Is Our Most Important Product

GENERAL ELECTRIC

A CHICAGO Stock Transformer



SAVED 8 WEEKS DELIVERY TIME ON THIS AccuRay® AUTOMATIC PROCESS CONTROL EQUIPMENT



CONTROL UNIT

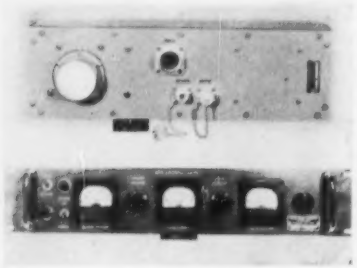
Industrial Nucleonics Corporation of Columbus, Ohio, needed the finest of dependable, high quality transformers in this equipment used to control steel strip thickness in the cold rolling of sheet steel. Units of another manufacturer did not fully meet required specifications. New, redesigned transformers would have required at least eight weeks delivery time.

Chicago Transformer PSC205 provided the ruggedness and reliability required for this equipment and was *available from stock for immediate delivery.* Thus Industrial Nucleonics was able to maintain its production and delivery schedules on this important equipment. PSC205 has been used continuously in the production of AccuRay® automatic process control equipment ever since.

Write for the free Chicago Standard catalogs listing over 1110 stock transformers.

USE CHICAGO STANDARD STOCK TRANSFORMERS TO ELIMINATE YOUR TRANSFORMER BOTTLENECKS

CHICAGO STANDARD TRANSFORMER CORPORATION
3501 ADDISON STREET • CHICAGO 18, ILLINOIS
Export Sales: Roburn Agencies, Inc., 431 Greenwich St., New York 13, N.Y.



produces an improvement in signal-to-noise ratio equal to that which would result from a five-fold increase in transmitter power, or an antenna gain increase by a factor of 5.

► **Size**—The preamplifier is 17½ in. long by 6¼ in. wide by 5¾ in. high and weighs 12¾ lb. By virtue of its small size it can easily be mounted at the antenna in most cases.

The separate power supply furnished with each preamplifier mounts in a standard 19 in. relay rack and may be placed at a remote point with respect to the preamplifier.

RESISTOR NETWORK
plug-in type

THE DAVEN CO., 530 W. Mt. Pleasant Ave., Livingston, N. J., has developed a new plug-in resistor network, type 1299. The unit is epoxymolded, hermetically sealed and measures ⅞ in. in diameter and 1¾ in. in length. Its base fits a standard 9-pin miniature socket.

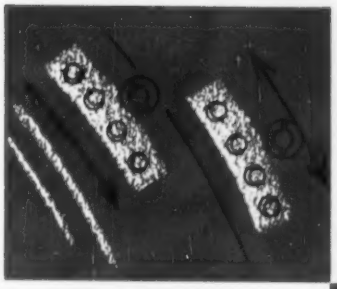
► **Specifications**—The plug-in resistor network can accommodate up to 8 individual resistors with a

A new and better variable-phase, single-turn precision potentiometer

CLAROSTAT

VARI-PHASE™

Pat. Pend.

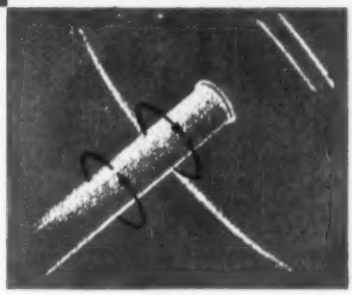


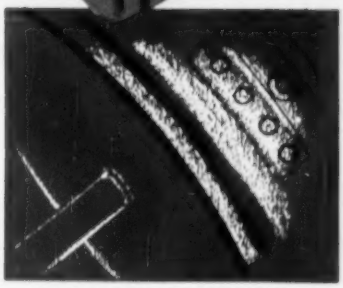
NO CLAMPING RINGS

Simplified phasing—External independent phasing of each cup without affecting the relationship of the others.—To phase, loosen clamping nut, move terminal board in desired direction, tighten clamping nut and it's done. Speedy phasing saves time and money. Reduced overall diameter by elimination of clamping rings.

EQUAL TORQUE AND TRACKING IN BOTH DIRECTIONS

Unique contact design permits micrometer tension adjustment at factory and assures equal torque and tracking in either direction at all times.





STANDARD A.I.A. MOUNTING

Mounting per A.I.A.* standards—others available. Meets or exceeds electrical and mechanical A.I.A. requirements.

Materials selected for lightest weight possible. Design assures highest performance.
Five sizes available—7/8", 1-1/16", 1-5/8", 2" and 3" diameters.

Another **CLAROSTAT** first. A product of advanced imagineering.

WRITE FOR COMPLETE ELECTRICAL AND MECHANICAL SPECIFICATIONS.

CLAROSTAT®

CLAROSTAT MFG. CO., INC.
DOVER, NEW HAMPSHIRE

In Canada: Canadian Marconi Co., Ltd., Toronto 17, Ont.
Manufactured under license in Great Britain by A. B. Metal Products Ltd., 17 Stratton St., London W.1, Concessionaires for British Commonwealth except Canada.

*Aircraft Industries Associated.

The
Curtiss-Wright "SNAPPER"

NEW CONCEPT...
ADVANCED DESIGN

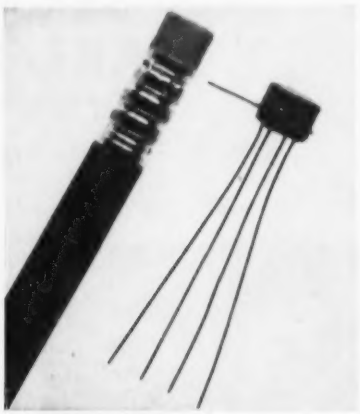
THERMAL TIME DELAY RELAY

Designed for high performance and long life, the Curtiss-Wright "SNAPPER" Thermal Time Delay Relay is proving itself in countless applications involving time delay in electrical circuits. Such applications include circuits to provide definite on-off time intervals to delay the application of high voltage until after warm-up period and for over and under voltage protection with simultaneous fault indication. These relays have single-pole double-throw contact action, high ambient temperature range, freedom from chatter and arcing, and are small in size. The "SNAPPER" thermal time delay relays are factory pre-set from 3 to 120 seconds. They are available in metal envelope, miniature (7 and 9 pin) or octal (8 pin) and in a glass envelope in 9 pin only. Curtiss-Wright manufactures the High-Low "SNAPPER" Differential Thermostat with high precision characteristics. Write for full data.

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

total resistance of 6 megohms. Individual resistor tolerances can be held to ±0.05 percent. It is operable from −55 C to +125 C. Each resistor can dissipate 0.5 w.

This new assembly can be supplied for other standard sockets or connectors, if required. It can also be furnished with modifications of physical size depending upon the number of resistors and their values.



TRANSISTOR
germanium tetrode type

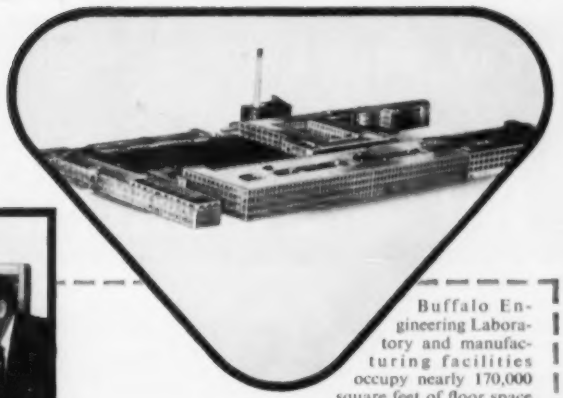
GENERAL ELECTRIC Co., Syracuse, N. Y., has announced a new germanium tetrode transistor produced by the company's melt-back process. It combines rugged construction and substantial power handling capabilities with high frequency performance.

►**Specifications** — Typical alpha cutoff of the new device is 50 mc at 85 C. It is rated at a minimum of 10 db power gain at 30 mc at 25 C with a 2-mc bandwidth. It is capable of dissipating 50 mw at 25 C and has a rise and fall time of 0.02 μsec.

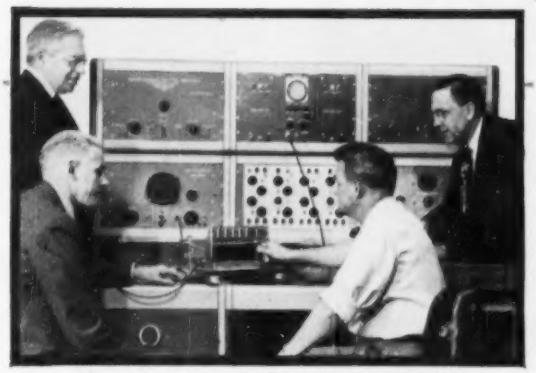
FILTER CHOKES
new hermetic series

UNITED TRANSFORMER Co., 150 Varick St., New York 13, N. Y. A new concept in filter choke design and ratings is effected in the hermetic series recently released. Designed to provide exceptional reliability through low temperature rise and high insulation safety factors, these

The right people with the right facilities produce the right solutions



Buffalo Engineering Laboratory and manufacturing facilities occupy nearly 170,000 square feet of floor space in this industrial center at 175 Great Arrow Ave., Buffalo 7, New York.



Observing measurement of circuit parameters in the Electronic Systems Division's Buffalo Engineering Laboratory. From left: *H. C. Tittle*, Manager—Buffalo Operations; *M. C. Scott*, Manager—Buffalo Engineering Laboratory; *R. W. Ferry*, Assistant Product Engineering Manager and *A. W. Puttick*, Product Engineering Manager.

Component of Airborne Countermeasure System.

"Packaged"

to deliver top performance—anywhere

THIS "PACKAGE" CAN GO anywhere, any time, in modern, high-performance aircraft, and deliver effectively in America's defense. It is an electronic countermeasure system. Designed, engineered, and "packaged" for minimum weight, the equipment provides maximum reliability and top performance under extreme conditions of humidity, altitude, shock, vibration, and temperature differential.

Engineered in the Buffalo Engineering Laboratory of Sylvania's Electronic Systems Division, this highly advanced electronic system employs subminiature tubes, transistors, and printed circuits in a package which is itself subminiaturized. Despite its complexity of design and purpose, it is engineered for quantity production in the Division's Buffalo plant.

In all of Sylvania's Electronic Systems Division installations, the right people work with the right facilities, within a sound managerial environment. That is why they have produced the right solutions to a variety of problems, and have made such important contributions in the fields of aviation electronics, guided missiles, countermeasures, communications, radar, computers and control systems. Whether the problem is military or industrial, Sylvania's business is to come up with electronic solutions that are *producible*.

In addition to its Buffalo Engineering Laboratory and manufacturing facilities, the Electronic Systems Division has installations at Waltham, Mass., and Mountain View, Calif., staffed with top-ranking scientists and engineers, and backed by Sylvania's extensive resources in the electronics field.

SYLVANIA IS LOOKING FOR ENTERPRISING ENGINEERS

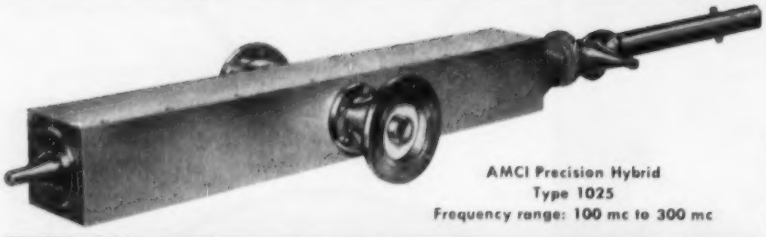
Sylvania has many opportunities in a wide range of defense projects. If you are not now engaged in defense work, you are invited to contact Edward W. Doty, Manager of Personnel, Electronic Systems Division, Sylvania Electric Products Inc., 100 First Avenue, Waltham 54, Mass.

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

NEW TOOLS *for* R-F MEASUREMENTS



AMCI Precision Hybrid
Type 1025
Frequency range: 100 mc to 300 mc

PERMITS DETECTION OF SWR's AS LOW AS 1.002

THE TYPE 1025 PRECISION HYBRID is a five-terminal, high-frequency network built with particular attention to stability and accuracy of construction. It makes possible the *measurement* of quantities that have been, normally, only estimated. For example: this device can be used to measure at about 200 mc. a reflection coefficient as low as 0.01, with a precision of ±0.001 in magnitude and ±5° in phase angle.

VERY LOW SWR's can be measured by using the Type 1025 Hybrid with a suitable receiver and signal generator. With additional equipment, the phase angle also can be obtained, permitting point-by-point plotting of impedance curves like the one shown at the right.

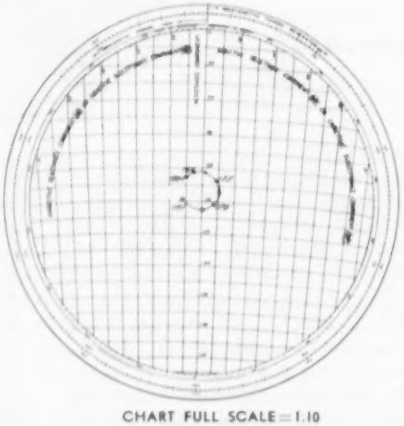
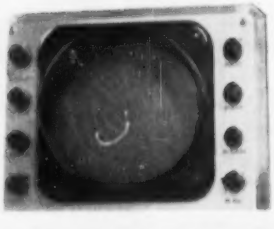
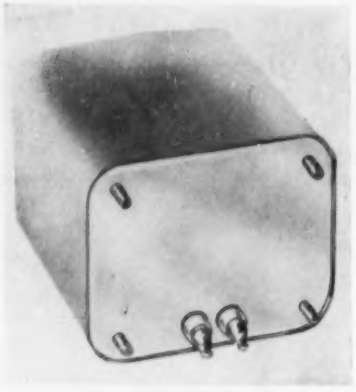


CHART FULL SCALE = 1.10



DIRECT DISPLAY OF IMPEDANCE can be obtained by using the Type 1025 Hybrid in conjunction with the AMCI type 1028 Polar Display Unit (frequency range 120 mc to 240 mc) together with a standard d-c oscilloscope and suitable swept oscillator. A typical display is shown in the unretouched photograph at the left.

AMCI
ANTENNA SYSTEMS – COMPONENTS – AIR NAVIGATION AIDS – INSTRUMENTS
ALFORD *Manufacturing Co. Inc*
299 ATLANTIC AVE., BOSTON, MASS.



hermetic filter chokes exceed MIL-T-27 specification requirements.

► **Features** — Four inductance-vs-current ratings for each unit provide maximum versatility in application. The ten units in the H series cover current values from 20 ma to 1,250 ma, with voltage ratings up to 3,000 v d-c.

These units also have industrial ratings for high reliability, broadcast, test equipment and similar service.

SILICON TRANSISTORS in large-scale production

BOGUE ELECTRIC MFG. CO., 52 Iowa Ave., Paterson 3, N. J., has available a complete line of precision durable silicon grown junction transistors. They will operate at peak efficiency under a wide range of operating conditions, including high temperatures.

► **New Characteristics**—Three important new characteristics in design are: high input operating voltage, higher collector operating voltage and decreased collector series resistance. These will permit silicon transistors to operate efficiently in the large signal applications necessary in magnetic

NOW AVAILABLE FROM
0.1 M.F.D. to 10 M.F.D.

Check these outstanding features:

- Accuracy in the order of 0.1% or better!
- Long Time stability in the order of 0.03%!
- I.R.—@ 25° C-10^{12} OHMS
- Dielectric Absorption—.015%
- Dissipation Factor—.0002
- Temp. Coeff. (—20° to 140° F.) 100 P.P.M. per °C

Excellent for Computer Integration, Test Equipment or Secondary Standards.

America's electronic leaders specify Southern Electronics' polystyrene capacitors for their most exacting requirements. Goodyear Aircraft, Beckman Instruments, Reeves Instrument Corp., Electronic Associates, Inc., Convair, M.I.T., Calif. Inst. of Tech., and many others. Make sure you're getting the finest—always specify S.E.C.!

Wire, write or phone for complete catalog today!

ADJUSTABLE
precision
polystyrene
capacitors

. . . WITH PERFECT HERMETIC SEAL TO INSURE EXTREMELY LOW LEAKAGE!

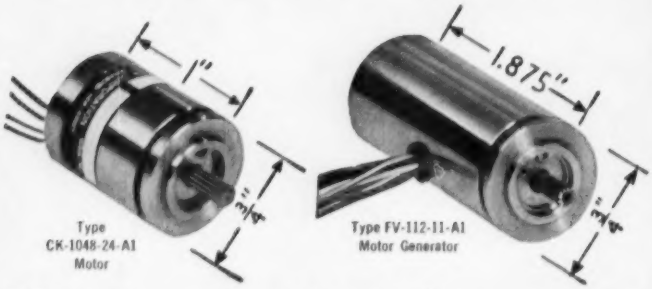
POLYCON SEC MYCON

SOUTHERN ELECTRONICS
Corporation

239 West Orange Grove Ave., Burbank, California

Want more information? Use post card on last page.

Need a *sub-miniature* low-inertia Servo Motor or Servo Motor Generator?



Here are two brand-new ones

by **Bendix**

TYPICAL MOTOR CHARACTERISTICS

	CK-1048-24-A1	FV-112-11-A1
Frame Size	8	8
Voltage: Fixed Phase	18 volts	18 volts
Control Phase	18 volts	18 volts
Frequency	400 cps	400 cps
Current*: Fixed Phase	.095 amp.	.095 amp.
Control Phase	.095 amp.	.095 amp.
Impedance:* Fixed Phase	190−158+j104 ohms	190−158+j104 ohms
Control Phase	190−158+j104 ohms	190−158+j104 ohms
Power Input* (Total)	3 watts	3 watts
Stall Torque	.15 oz-in	.15 oz-in
No Load Speed	6300 rpm	6300 rpm
Rotor Moment of Inertia	.5 gm-cm²	.8 gm-cm²
Torque to Inertia Ratio	21,000 rad/sec²	13,000 rad/sec²
Weight	1.5 oz.	2.5 oz.
Operating Temperature Range	−55°C to +100°C	−55°C to +100°C

*At stall with rated voltage applied to each phase

TYPICAL GENERATOR CHARACTERISTICS

Voltage: Input	18 volts
Output	.250 volts/1000 rpm
Frequency	400 cps
Linearity	½ of 1% up to 3000 rpm
Input Impedance	178−135+j115 ohms
Recommended Output Loading	100,000 ohms
Power Input	1.5 watts
Null Voltage	15 millivolts max.

These latest additions to the Eclipse-Pioneer line are now in initial production. They're another forward step in the continuing development of Bendix components to meet modern space, accuracy and weight requirements. For full details, write stating your specific needs. DEPARTMENT A, ECLIPSE-PIONEER DIVISION, BENDIX AVIATION CORPORATION, TETERBORO, N. J.

Let "by Bendix" be your guide to *BUY BENDIX*

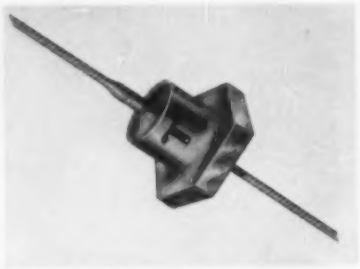
West Coast Office: 117 E. Providencia Ave., Burbank, Calif.
Export Sales and Service: Bendix International Division, 205 E. 42nd Street, New York 17, N. Y.

Eclipse-Pioneer DIVISION

Bendix AVIATION CORPORATION

amplifier, computer and servo applications.

The new transistors are currently available in two categories, one with emitter voltage of 2 v and the other, the "A" category with emitter voltage of 5 v. Four types of transistor in each series cover a wide range of special operating requirements.



SILICON RECTIFIERS
axial lead types

TRANSITRON ELECTRONIC CORP., Melrose 76, Mass., has available axial lead silicon power rectifiers which offer versatile mounting arrangement for printed circuits or standard terminal boards.

► **Specifications**—They are available with peak inverse voltage ratings up to 600 v, and maximum average forward currents to 500 ma at 100 C. They feature both high forward conductance and low leakage current for high operating efficiency.

Small size (less than ¼ cu in. total volume) and hermetic sealing ideally suit these rectifiers for use in military equipment or similar applications where miniaturization and reliability are of importance. Complete information is given in bulletin TE-1335.

LAB TEST DEVICE
gas analyzer, vacuum pump

BARRY ELECTRONICS CORP., 512 Broadway, New York 12, N. Y. Model 1 is a combination leak tester, gas analyzer and vacuum pump. The unit includes built-in vacuum pump, vacuum gages, all neecssary control valves and a gas analyzer cell for identification of system leaks. This test apparatus is self-contained in a single top-of-

RACK MOUNT STYLE—5¼" high by 18" wide by 15⅛" deep

PORTABLE STYLE—10⅞" high by 8⅜" wide by 15⅛" deep

Now! Accurate automatic measurements for varied industrial applications...

NOW EVERY FEATURE you want in a precise, automatic Digital Voltmeter is available in these new Non-Linear Systems models. Their *performance* features automatic measurement from zero to ± 999.9 volts DC with high accuracy and resolution. *Fast readings* are presented in a brilliant, in-line luminous numerical display. *Automatic features* simplify operation, enable you to use non-technical employes. Assured *long life* results from exclusive NLS *oil-sealed* stepping switch system, plus top-quality components. Thorough *quality control* ensures reliable operation. And unitized construction means *simplified maintenance*, saving you time and money.

Yet NLS Model 451 Digital Voltmeters are priced far below instruments offering only a fraction of these advantages! These low costs are possible because NLS, as originators of the Digital Voltmeter, has the advantage of pioneering design and production techniques. Furthermore, NLS quantity production results in additional savings.

You can save time and money, and assure automatic accuracy in precision measuring, with an NLS Digital Voltmeter. Mail coupon today for more information on how these quality instruments can assist your operations.

YOU GAIN THESE ADVANTAGES

Automatic operation — Simple operation plus brilliant numerical readout and recording allows use of non-technical personnel.

Exhaustive quality control — Sustained accuracy assured by systematic testing procedure throughout all engineering, production phases.

Unitized, standardized construction — Each instrument can be quickly disassembled into three functioning subassemblies.

Quality components, including mercury-cell reference standard, stepping switches built to NLS specifications, precision resistors and other high standard components.

Oil-sealed stepping switch subassembly cuts maintenance, boosts switch life, ensures reliability under all operating conditions.

Long-life stepping switches — Life tests corresponding to 21,000,000 readings completed, with switches still operating!

Simplified maintenance, resulting from unitized construction, saves you time and money.

No-lost-time service — Interchangeable subassemblies and complete instruments available promptly.

Automatic recording by electric typewriter, printer, summary punch.

Low initial cost, based on NLS integrated, efficient production methods, and on advanced engineering developments.

New! Automatically-standardized reference power supply eliminates manual adjustment; available instead of internally-mounted mercury-cell battery pack.

APPLICATIONS

Automatic measurement, digital display and recording of DC voltages for:

Manufacturing — Development, production and process control testing.

Laboratories — Precision standardization procedures.

Special test equipment — Analog computers, missile components, control systems.

Many more! Our application engineers are available to work with you.

NLS

NON-LINEAR SYSTEMS

TWX: Del Mar 6-345 — PHONE: SKyline 5-1134

ORIGINATORS OF THE DIGITAL VOLTMETER

Digital Ohmeters • AC-DC Converters • Digital Readouts
Data Reduction Systems • Peak Reader Systems
Digital Recording Systems • Binary Decimal Converters

NON-LINEAR SYSTEMS, INC.
Dept. B-456, Del Mar Airport, Del Mar, California

Send new '56 catalog on complete line of precision instruments, and current price list.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

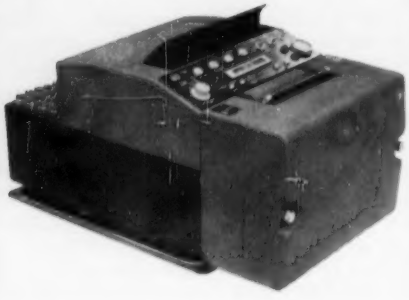
Want more information? Use post card on last page.

vital tests?

lots of data?

Here's the acknowledged peak of recording oscillograph development – CEC's Type 5-119, usable for over 90% of all static-dynamic tests, regardless of their complexity. An unusual group of *built-in* safeguards against data loss has proved especially valuable in aircraft flight testing and in missile testing, where conditions are often impossible to duplicate and lost data can mean tens of thousands of dollars. In the air or on the ground, you can be *sure* when you use the CEC 5-119.

then try CEC's 5-119 recording oscillograph



Also, the 5-119R, especially engineered for vertical installation. Effectively shock mounted, using little space, it's ideal for both stationary and mobile rack mounting... tilts forward easily for loading and adjustment.

The 5-119 records up to 50 channels on records 12″x250 ft at speeds from 0.1 to 100 inches per second. *Instant* speed change of 10:1 is effected through a simple switch control. It uses standard CEC Galvanometers, with linear frequency response from 0 to 3000 cps. All controls and warning lamps are located on the front panel.

For complete information about the 5-119 oscillograph, write today for CEC 1536B-X3.

Consolidated Electrodynamics
CORPORATION
formerly Consolidated Engineering Corporation
ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL
300 North Sierra Madre Villa, Pasadena, California

Sales and Service Offices in: Albuquerque, Atlanta, Boston, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D. C.

bench cabinet with all controls and gages conveniently located on the front panel. The portable, versatile instrument is suited for altitude test chambers, evacuation of tubes, and leak detection of mechanical and electrical components.

C-R-A-M UNIT
widely versatile instrument

RADIO FREQUENCY LABORATORIES, INC., Boonton 3, N. J. Model 1051 C-R-A-M (calibrator-receiver-amplifier-mixer) is intended for use (1) as a secondary frequency standard of 0.0005-percent accuracy, (2) for the reception of standard time and frequency broadcasts from WWV, (3) as a moderate gain audio amplifier for general use, and (4) as a mixer to compare two external signals to each other or to compare one external signal to one of the harmonics or subharmonics of its 10-mc crystal oscillator.

The unit has a self-contained regulated power supply. Overall dimensions are 10 in. wide by 11 in. high by 9 in. deep. Weight is approximately 24 lb.

TANTALUM CAPACITOR
featuring high stability

FANSTEEL METALLURGICAL CORP., Rectifier-Capacitor Division, North Chicago, Ill. Type STA tantalum capacitor has favorable characteristics over a temperature range from −70 C to +85 C. From room temperature to −70 C, capacitance

$1.00
70¢
SMALLER AND LESS EXPENSIVE
The G-E Vac-u-Sel rectifier stack (in red) gives the same life, current capacity, and performance as the larger, ordinary selenium stack. Low-cost Vac-u-Sel rectifier stacks are ideal for such applications as coin-operated machines.

DESIGNED TO HELP YOU MEET PRICE COMPETITION . . .

G-E *Vac-u-Sel** Rectifiers Cost You Up to 30% Less

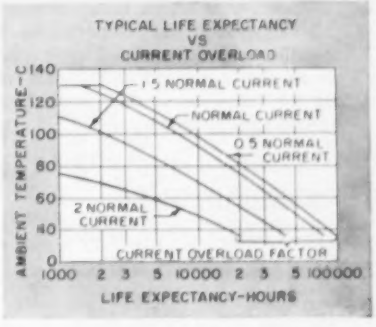
Here is a component rectifier stack that will out-perform ordinary selenium stacks, and yet cost you up to 30% less!

INITIAL COST IS OFTEN 30% LOWER: G-E Vac-u-Sel rectifiers can be made up to 30% smaller for any given application, due to the greater current-carrying capacity of the individual cells. Smaller size means a lower cost to you. These cells are produced by a unique G-E sphere-type vacuum-evaporation process that enables us to accurately predict the output and life characteristics of any model number. We are thus able to give you a stack with the exact life you require. You don't pay for more life than you need.

PICK THE LIFE YOU WANT: You can select a Vac-u-Sel rectifier that will last up to 80,000 hours—or more. But if your application calls for shorter life, we can give you a smaller, less expensive stack, which operates at greater than normal-rated current. You will find that even when overrated these top-quality G-E Vac-u-Sel rectifier stacks will perform with greater predictability than ordinary selenium. So, by tailoring each stack to meet your exact requirements, you receive the benefit of top quality at lower cost.

Contact your G-E Apparatus Sales Office, or write for Bulletin GEA-6273 to: Section 461-41, General Electric Co., Schenectady 5, N. Y.

* Vac-u-Sel is a trade-mark of the General Electric Co. It designates top-quality selenium rectifier cells manufactured by a unique sphere-type vacuum-evaporation process by the Rectifier Department, Lynn, Mass., headquarters for silicon, germanium, selenium, and copper-oxide component rectifiers.



LONG LIFE is provided by G-E Vac-u-Sel rectifier stacks—even at high operating ambients and better than normal-rated current.

Progress Is Our Most Important Product

GENERAL ELECTRIC

size: 1¼" x 1½" x 2⅜"
weight: less than 7 oz.

LOW-LEVEL MAGNETIC D. C. SIGNAL AMPLIFIER

for thermocouple and strain gage applications in telemetering systems

RUGGED, ALL-MAGNETIC construction assures exceptional stability under the most severe conditions. No moving parts, no fragile elements. Unit withstands extreme vibration and shock without introducing spurious noise, and delivers reliable performance in high environmental temperatures. Produces 5 VDC output from 1 millivolt DC input, with exceedingly high gain stability. Used in all major aircraft and missile instrumentation projects as well as for temperature and strain measurements in industrial and medical applications.

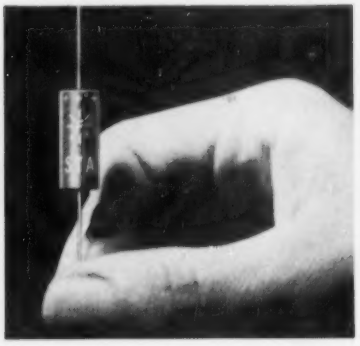
FEATURES

- Gain change of less than 2% for temperature change of 100° C.
- Gain change of less than ½% for line voltage changes from 105 to 125 volts.
- High DC voltage gain, ripple-free. 5 VDC output from 1 millivolt DC input.
- Responds only to DC; signal sensitivity 10^{-12} watts
- No pickup – no lead shielding required.
- All magnetic – maintenance-free.
- Response time 40 milliseconds.
- No tubes – no warm-up time, generates no heat.
- Power requirements less than 10 milliwatts.
- Temperature compensated control circuit.
- Hermetically sealed in thermosetting plastic.
- Magnetically shielded.
- Long life, extremely rugged and reliable.
- Operates from standard 400-cycle supply.

for further information, write for Bulletin EB-201-A

MAGNETIC RESEARCH CORP.
200 CENTER STREET • EL SEGUNDO, CALIFORNIA

Mfrs. of Magnetic Amplifiers and Converters, Magnetically Regulated DC Power Supplies, Magnetic Pulse Generators.



and power factor are practically constant.

The capacitor will operate more satisfactorily at higher frequency than conventional electrolytic capacitors.

▶ **Makeup**—The new STA uses a porous sintered tantalum anode with an electromechanically formed tantalum oxide dielectric, which provides large capacitance in small pace with exceptional chemical and electrical stability.

ITV EQUIPMENT
new remote control type

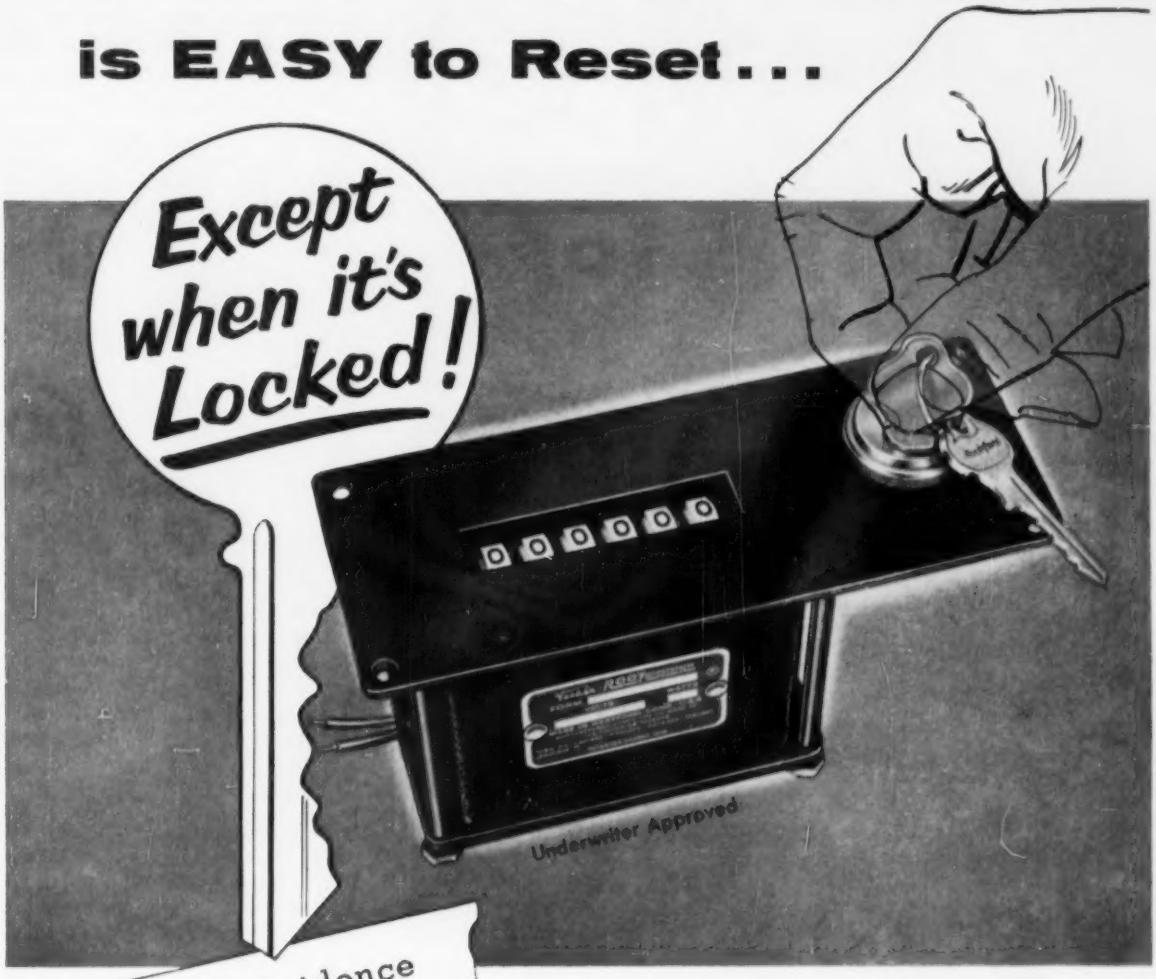
GENERAL PRECISION LABORATORY INC., Pleasantville, N. Y., has announced new remote control of its closed-circuit industrial and institutional equipment including camera, lens iris and focus, indoor and outdoor pan and tilt, and weatherproof housing.

▶ **Remote Operation** — The equipment is highly suitable for surveillance work and remote monitoring of operations. Full 360-deg camera viewing and 90-deg tilt are obtainable with both indoor and outdoor mountings.

Two restyled camera control

This NEW Magnetic Counter

is EASY to Reset...



Added Evidence that —

Everyone Can Count on VEEDER-ROOT

Designed for panel mounting where remote indication is required, this electrically operated counter is a compact package 5.5″ long, 2.1″ wide, 2.7″ high. Capacity: 1,000 counts per minute. Power consumption, 8 watts. Stocked in 110 and 220 AC and DC. Easy to reset, except when locked . . . then the sturdy tumbler-lock* puts the damper on tampering. Yet one turn of the key resets all 6 figures to zeros.

This new Magnetic Counter is one of the thousands of Veeder-Root standard and special counters . . . electrically, mechanically and manually operated . . . in daily use throughout the world in industry, business, science and medicine. You, too, can count on Veeder-Root . . . to help you count anything you need.

*National Lock Co. Lock No. 68-4837, Key D-428

Stocked at
Hartford 2, Conn. • New York 19, N. Y.
Greenville, S. C. • Chicago 6, Ill.
Montreal 2, Canada
Offices and Agents in Principal Cities

VEEDER-ROOT
"THE NAME THAT COUNTS"

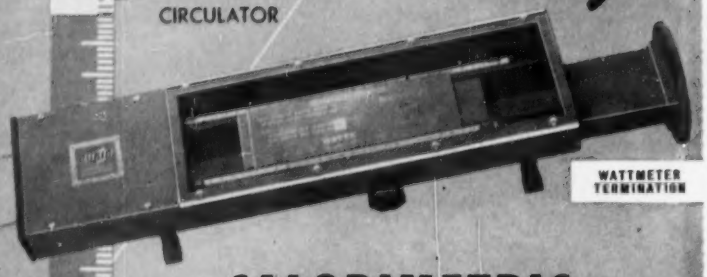
Want more information? Use post card on last page.

MICROWAVE POWER MEASUREMENT FROM DEGREES...

SPECIFICATIONS
Av. Power 0-600 watts
Peak 600 KW
VSWR 1.1 max.
Freq. range
Basic unit 2.6 to 3.95 kmc
With Adapters 2.6 to 18.0 kmc

...TO WATTS directly!

CIRCULATOR



WATTMETER TERMINATION

CUBIC'S 2-UNIT CALORIMETRIC WATTMETERS

... for obtaining direct power readings in testing electronic equipment—without guessing!

Three of the world's largest producers of electronic equipment have recently made CUBIC Calorimetric Wattmeters standard test equipment in their laboratories and plants. For very good reason. No other instrument designed for power measurement gives you direct power readings... with such precision, and yet so simple in its application.

The model shown is the MC-1B for power measurement from 2600 to 26,500 MC. Also available are the models MCX-1A (coaxial type) for power measurement from 100 to 3000 MC, and MCL-1A (L-Band waveguide type) for power measurement from 1120 to 2600 MC.

Whether checking field equipment, developing or making acceptance tests on new equipment or magnetrons in the lab, or in production, one of CUBIC'S Calorimetric Wattmeters will be an invaluable addition to your test equipment. Standard laboratories calibrate secondary power devise, especially bridge type bolometer instruments. Exact calibration is provided month to month.

Write for more information, and ask for our catalog of other test equipment and waveguide components. Or if you have a problem in development or engineering, CUBIC offers the services of its engineering staff and facilities in its solution.

CUBIC CORPORATION
ELECTRONIC EQUIPMENT RESEARCH...DEVELOPMENT
2481 CANON STREET, SAN DIEGO 6, CALIFORNIA

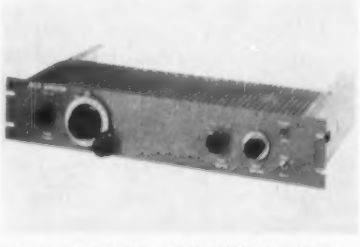
units, portable and wall-mounted, are also available with plug-in control panels which may be removed to provide remote operation of beam, focus, target, blanking and gain.

ELECTRICAL CABLE
200 percent expandable

UNITED CABLE CORP., Division of Mutual Electronic Industries Corp., Beechwood Ave., New Rochelle, N. Y., has announced Elasticable, an expandable electrical cable constructed of braided 21-strand conductor with a covering of rayon, nylon or rubber.

► **Sizes**—One to six conductors finished with spade terminals, alligator clips or jacks are available in stock sizes of 2, 3 or 4-ft relaxed lengths; other sizes to order.

Expansion is over 200 percent. Voltage insulation is 1,000; current twin conductor, 4 amperes. Prices of the cables are determined by length, quality of cover, number of conductors and type of terminal.



H-F PULSE GENERATOR
designed for rack mounting

BURROUGHS CORP., 1209 Vine St., Philadelphia 7, Pa. The No. 1050 pulse generator is designed for

DESIGN
RESEARCH
PROTOTYPE DEVELOPMENT
MASS PRODUCTION

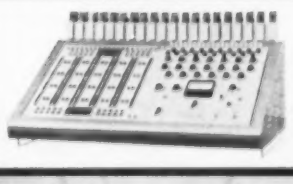
HALL-SCOTT
ELECTRONICS

Ideas That Become Finished Products

You can expect intelligent solution of your design problems, with fast processing to finished product, when you use the completely integrated development and production facilities of Hall-Scott Electronics. Advanced electronic engineering, manufacture, and assembly—including precision sheet metal work—are all carried on under one roof in an ultra-modern plant. Hall-Scott laboratories include advanced condition, simulation, electrical and mechanical testing equipment. The shops are tooled for efficient production of the most complex electronic equipment.

You can also expect the same high standards that have made the name Hall-Scott synonymous with dependability in research and development for industry and government over the past 40 years.

No matter what your electronic project may be, write for complete information on how Hall-Scott Electronics can assist you... 2950 North Ontario Street, Burbank, California, Dept. E-456.



Desk-top **Analog Computer**, rapid and economical system synthesis.

Plug-in DC **Amplifier**, a system building-block.

Work now in process includes Ground Control Components for Missiles, Sensing Devices, Electronic Analyzers, Transistorized Power Packages, Plug in DC Amplifiers, Pre-flight Test Equipment, and Analog Computers.

HALL-SCOTT Since 1909

Hall-Scott Motors Company, *Electronics Division*

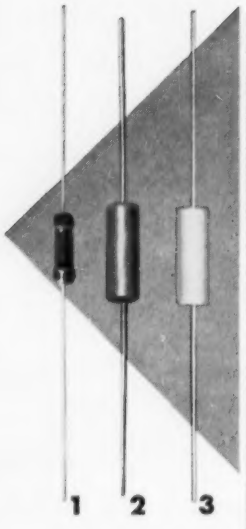
Burbank, California

Want more information? Use post card on last page.

ELECTRA

Your Best Source For All Types of
DEPOSITED CARBON RESISTORS

1. *Standard*
2. *Molded*
3. *Hermetically Sealed*



Electra, a pioneer manufacturer, offers you a *complete line* of precision Deposited Carbon Resistors. Chances are your firm has modified its designs to specify deposited carbon resistors. No matter what your needs, you'll find the right resistor among the 16 physical sizes in Electra's complete line. Available in 1/8 watt to 3 watt capacities and resistance ranges of 2 ohms to 50 megohms.

STANDARD

Manufactured to meet or exceed specification MIL-R-10509A, Electra's standard resistors offer you the largest capacity in the *smallest physical size.* Available in 8 sizes, this resistor gives you accuracy and stability plus Electra's improved, exclusive insulation at the *lowest possible cost.*

MOLDED

Give you every advantage of Electra's standard resistor, *and more!* Molded plastic case gives you *extra* mechanical protection, *longer* load life, *better* insulation against electrical shock and humidity. Meets or exceeds specification MIL-R-10509B (Proposed).

HERMETICALLY SEALED

Designed to meet the roughest, most rigid requirements. Sealed in impervious ceramic sleeve with special silver alloy solder. Maximum protection against rough handling, temperature extremes, humidity, exposure to chemicals. Meets or exceeds specification MIL-R-10509B (Proposed).

Electra
MANUFACTURING COMPANY

4051 Broadway WE 1-6864
Kansas City, Missouri

FILL OUT THIS COUPON TODAY!

Please send me the following catalog specification sheet(s). Standard Bulletin 50 . . . Molded Bulletin 70 . . . Hermetically Sealed Bulletin 60 . . .

Name_____

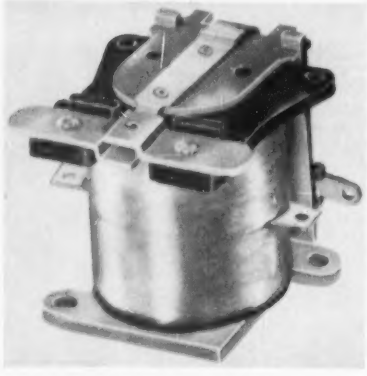
Company_____

Street_____

City_____ State_____

testing, information handling, and control wherever extra high frequencies are required. Output is ½ sine wave pulse, with adjustable width from 0.03 μsec to 0.07 μsec in 5 bands. Frequency range is from 1.6 mc to 10.4 mc in 4 overlapping bands. The generator utilizes the same standard voltages as all other Burroughs pulse control equipment.

Designed for rack mounting, the unit measures 19 in. by 3½ in. by 10 in. with amateur notches.



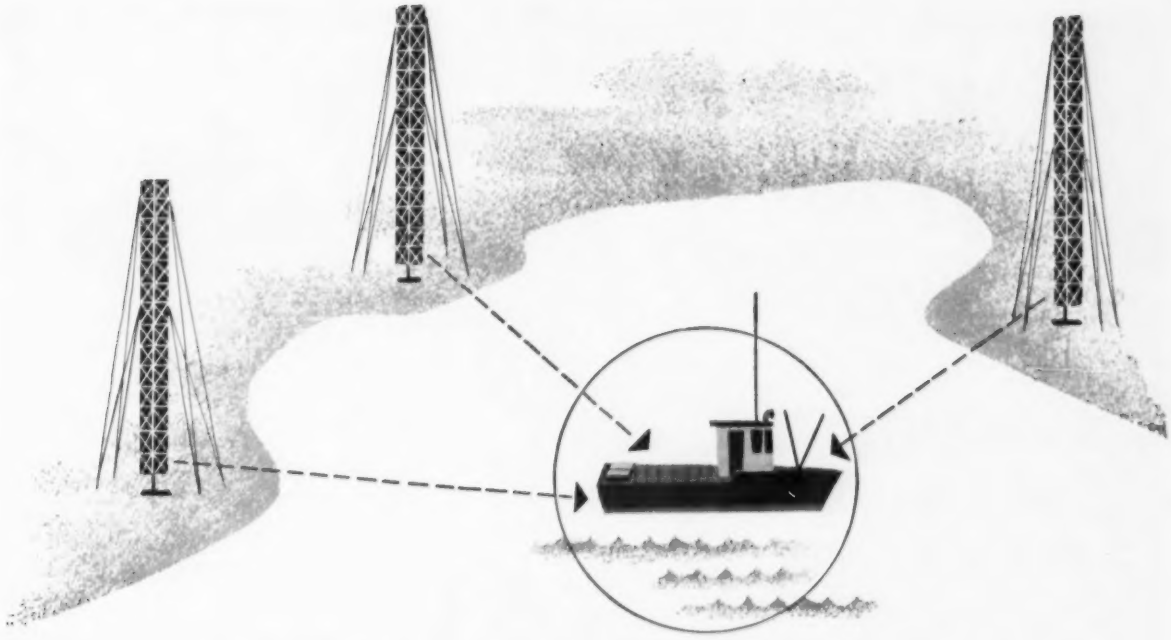
SENSITIVE RELAY
features different design

STERLING ENGINEERING, Princeton, Ind., announces a new low-cost sensitive relay which, due to its unusual mechanical design, provides 15 percent more winding space than similar conventional design. Results are high contact pressures and high resistance to vibration.

▶ **Specifications**—Sensitivity is 40 mw; coil resistance, up to 22,000 ohms; operating shock, 25 g; vibration over 10 g, 10 to 60 cycles; weight, only 1⅛ oz.

POTENTIOMETERS
smaller size, lighter weight

THE GAMEWELL CO., Newton Upper Falls 64, Mass. Model RVG-14 is a ¾ in. diameter, ¾ oz precision potentiometer specifically designed to meet the increasing demand for smaller size and lighter weight with good linearity. It features dependable performance, particularly where severe vibrations and



how Transicoil servos help LORAC

bring off-shore navigation to accuracies within yards

LORAC (LOng Range ACcuracy), one of the newest methods of close tolerance navigation, is now providing pin-point positioning for ships at sea, well away from land or other navigational markers. Developed by the Seismograph Service Corporation, this novel system compares the phase relationship of three sets of radio signals to fix position.

Lorac accuracy depends on the ship's receiver having laboratory type dependability and precision under extreme corrosive atmosphere and rough handling. Yet the servo phase resolver and indicator can spot position to within a matter of yards.

This all-important servo indicator-package was designed and built by Transicoil to meet the specific requirements of shipboard use.

When coupled to the electronic section of the receiver, this unit continuously measures the phases of the incoming signals by comparing the phase of the beat frequency with a modulated reference signal, and presents the position information on the counter-pointer type dial face.

The Transicoil servo assembly used in the Lorac receiver. Components include a 400 cycle oscillator supply for two indicators and two servo amplifiers. System is built on separate chassis to permit the indicators and amplifiers to be located in separate parts of the ship.

The Lorac system is typical of the way in which Transicoil can solve your servo problems to bring new measures of accuracy and dependability. Transicoil will develop and manufacture a complete "package" servo system to conform to your individual requirements. You pay only for results—on a fixed fee basis for equipment delivered and functioning properly.

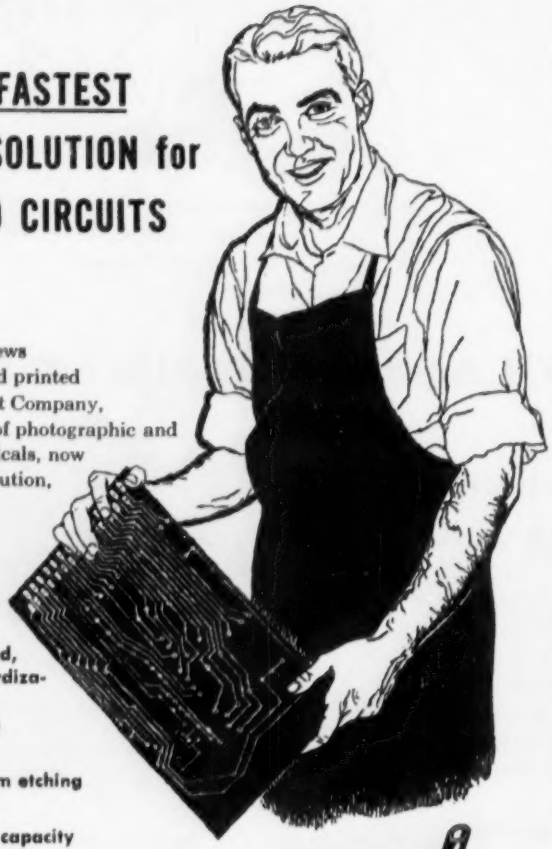
Write today for further information, outlining your servo problem.

TRANSICOIL CORPORATION

Worcester, Montgomery County · Pennsylvania

"PRINTED CIRCUIT OUTPUT UPPED when we switched to HUNT R.C.E." (RAPID CIRCUIT ETCH)

—the FASTEST ETCHING SOLUTION for PRINTED CIRCUITS



Here indeed is good news for all makers of etched printed circuits. Philip A. Hunt Company, world-famous makers of photographic and photo-engraving chemicals, now offers Hunt R.C.E. Solution, a special etching solution with these BIG advantages, *guaranteed:*

1. Controlled rapid etching speed, permitting standardization of a high production etching schedule
2. Instant and uniform etching over entire circuit
3. Maximum etching capacity
4. Full protection of tops

Contact your nearest Hunt branch, or write us at Palisades Park, N. J., today for full information on Hunt R.C.E. Solution.

Hunt R.C.E. Solution is supplied in 145 lb. rubber drums

Manufacturing Chemists — HUNT — Established 1909

PHILIP A. HUNT COMPANY

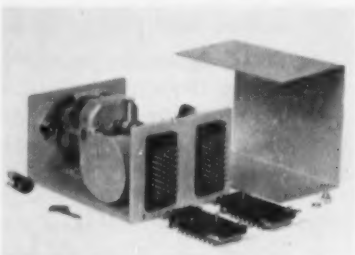
PALISADES PARK, N. J.

Chicago · Cleveland · Cambridge · Brooklyn · Atlanta · Dallas · Los Angeles · San Francisco

high operating temperatures are encountered.

This metal-housed potentiometer is available in single as well as multigang construction, with sleeve or ball bearings.

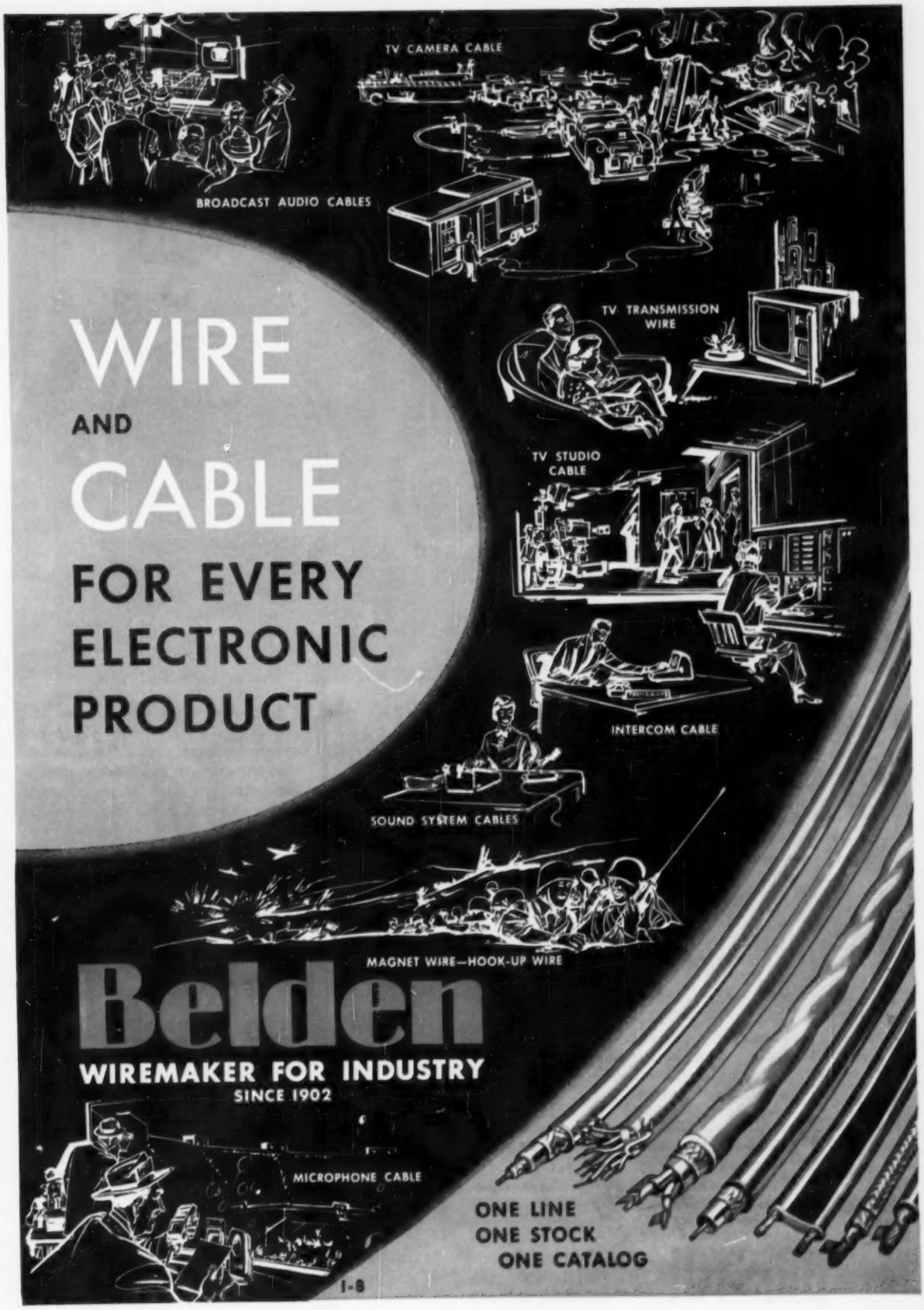
▶ **Specifications**—Winding resistances from 25 to 45,000 ohms may be had with minimum resolution of 0.06 percent and optimum linearity of 0.25 percent where specified. Maximum continuous operating temperature is 150 C, and the units meet MIL-E-5272A specification as they apply.



COMPENSATION SWITCH handles computer drift

THE APPLIED SCIENCE CORP OF PRINCETON, P. O. Box 44, Princeton, N. J. The new computer drift compensation switch is primarily for use in electronic analog computers to connect a single a-c compensating amplifier in sequence to a number of d-c computing amplifiers for zero drift or offset compensation. It may also be used in other applications where a rotary compensator of high quality is required.

▶ **Specifications**—The switch has two poles and is available with 60 or 80 make-before-break contacts per pole at sampling speeds ranging from 3.5 to 4 rps. The


TV CAMERA CABLE
BROADCAST AUDIO CABLES
WIRE
AND
CABLE
FOR EVERY
ELECTRONIC
PRODUCT
TV TRANSMISSION WIRE
TV STUDIO CABLE
INTERCOM CABLE
SOUND SYSTEM CABLES
MAGNET WIRE—HOOK-UP WIRE
Belden
WIREMAKER FOR INDUSTRY
SINCE 1902
MICROPHONE CABLE
ONE LINE
ONE STOCK
ONE CATALOG
I-8

WHAT'S NEW AT BRISTOL...

BRISTOL'S SYNCROVERTER SWITCH is made to fit 7-pin miniature tube socket *(left)* or ¾-in. diameter chassis hole *(right)*. Covered by patents.

"Most reliable miniature chopper we've tested!"

That's the playback we're getting from electronic engineers all over the country on the high-performance Bristol Syncroverter® switch. One engineer writes:

"In seven years of experience in applying similar devices, we have not found a chopper as reliable . . . after our tests no deterioration in performance was found, and we believe there is no equivalent meeting our requirements."

Another electronics engineer comments on his life-tests:

"The switch has passed the 1000-hour mark without the slightest degradation of the wave form."

The Syncroverter switch has a normal *operating life of thousands of hours*. It's a polarized, SPDT, non-resonant switch that provides break-before-make action in synchronism with a sine or square-wave driving current anywhere in the frequency range of 0 to 2000 cps. In addition to reliability and long life, it's noted for light weight (only 1.7 ounces) low noise level, and clean wave form.

Write today for free bulletin on the high-performance Syncroverter switch. The Bristol Company, 152 Bristol Road, Waterbury 20, Conn. 6.10

TYPICAL OPERATION

	400 cps	500 cps
Coil voltage	6.3V sine, square, pulse wave	6.3V sine, square, pulse wave
Coil current	55 milliamperes	45 milliamperes
Coil resistance	85 ohms	85 ohms
*Phase lag	55° ±10°	65° ±10°
*Dissymmetry	less than 4%	less than 4%
Temperature	−55°C to 100°C	−55°C to 100°C
*Switching time	15° ±5°	15° ±5°

Mounting—Any position—fits 7-pin miniature socket

*These characteristics based on sine wave excitation

BRISTOL FINE PRECISION INSTRUMENTS FOR OVER 60 YEARS

phasing between poles is adjustable. This switch is 5¾ in. long by 7 in. wide by 4½ in. high and weighs approximately 9½ lb.

SILICON DIODE
for X-band mixer use

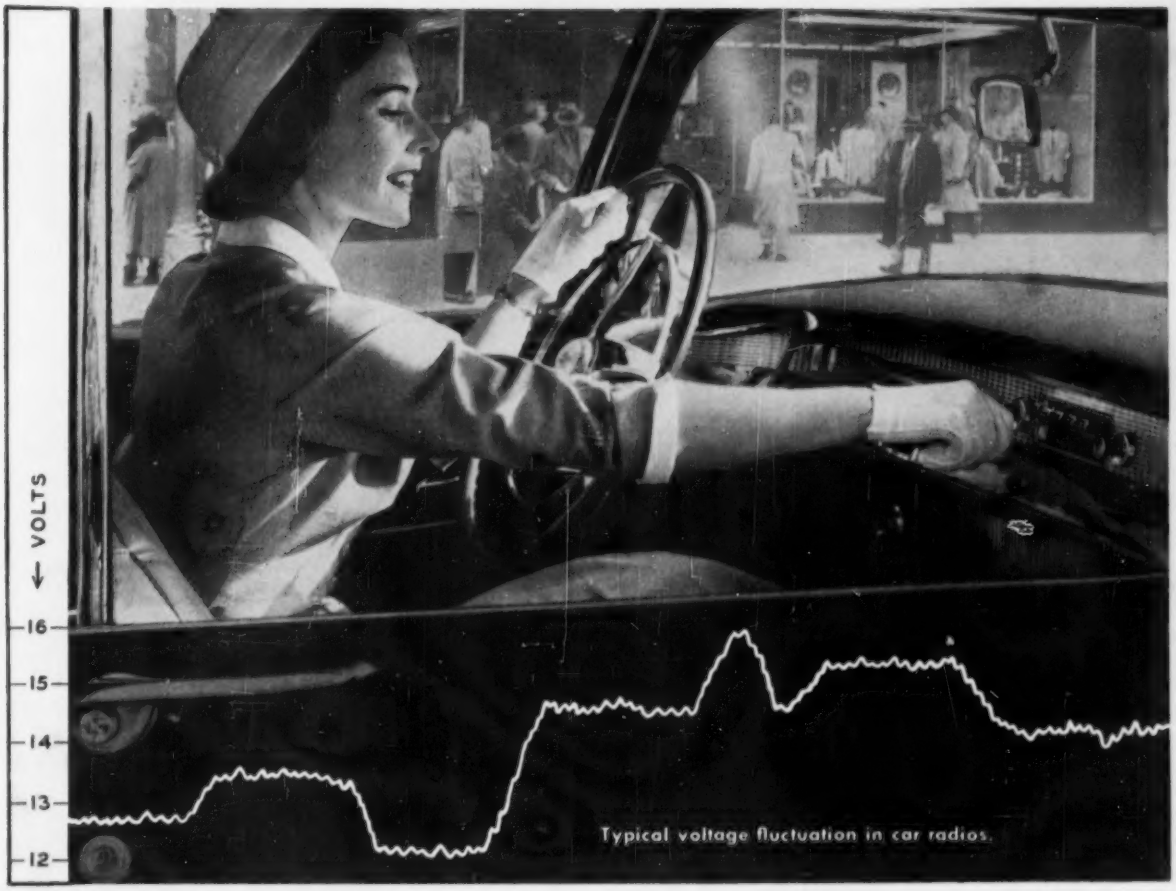
BOMAC LABORATORIES INC., Beverly, Mass. The 1N23D high sensitivity silicon diode can lower the overall system noise down to 7.5 db in a system with well-designed plumbing. It is designed for X-band mixer use in superheterodyne receivers where low overall noise and minimum conversion loss are required. These characteristics enable the systems engineer to design for both maximum receiver sensitivity and maximum output signal to noise ratio.

▶ **Other Uses**—With proper mounting and circuitry these diodes may also serve as low-level detectors and measuring devices in the X-band region.

Both normal and reversed polarity are available.

DUAL D-C SOURCE
for transistor biasing

ELECTRONIC RESEARCH ASSOCIATES, INC., 67 E. Center St., Nutley, N. J. Model 310 is a regulated dual output high current tubeless supply specially designed to power both high and low-current transistors. Other applications include computer magnetic memory devices, d-c filament supply, solenoid and magnetic-clutch operation, and all types of regulated, d-c high-current lab-



FOUND: a Cathode alloy that prolongs tube life under fluctuating voltage

CATHALOY* A-31 IDEAL FOR CAR RADIO TUBES. This discovery was made in actual car radio installations. Heater supply voltages were found to vary up to 25% above specification. And the tubes using Superior's new Cathaloy A-31† consistently outlasted others.

These findings prompted car radio manufacturers to insist on longer-life tubes in car radio service. Specifications stipulate several hundred hours at approximately 25% overvoltage. No cathode alloy can match Superior's Cathaloy A-31 in meeting these requirements.

OTHER ADVANTAGES. Cathaloy A-31, with its 4% tungsten, is probably the strongest cathode material at high temperatures that is commercially available today. Hence it qualifies especially for use in ruggedized tubes. In addition, its special composition reduces the twin problems of sublimation and interface impedance.

SEND FOR FREE CATALOG. Contains complete technical information on Cathaloy A-31 and other cathode alloys and on electronic tubular parts. Write Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.

Cathodes made from A-31 are available in Weldrawn, Lockseam † and disc cathodes.*

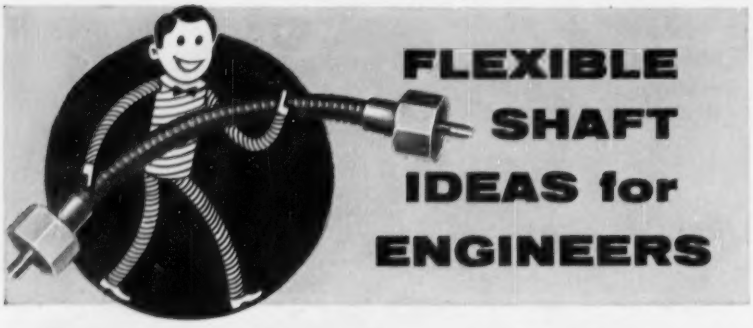
• • •

*T.M. Reg. U.S. Pat. Off., Superior Tube Co.
†Manufactured under U.S. patents.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.



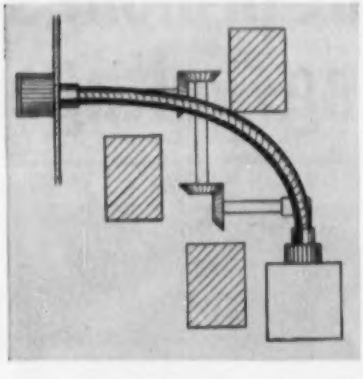
One part does the work of many when you use a flexible shaft

Design simplification is one of the reasons why it pays to use S.S.White "Metal Muscles"®

IT'S A DESIGNER'S AXIOM that simplification is one of the most effective ways of reducing product costs. By so doing, you save weight, you eliminate a number of unnecessary parts and you reduce assembly time and costs.

Eliminating Parts

When it's a question of transmitting rotary power or providing remote control, especially where turns or alignment are involved, an S.S. White flexible shaft is an efficient cost-saving solution. The illustration below demonstrates why this is so.



One flexible shaft is all it takes to do a job that might otherwise require an entire system of bevel gears, straight shafts, universals, etc. Added to this is the fact that installation is greatly simplified and alignment problems are eliminated.

90% Cost Reduction

Actual cost figures on a control set-up for a large dual hydraulic power system dramatize how effectively flexible shaft simplification can cut costs.

In this case, 35 parts including universal rods and bevel geared elbows were being used to transmit control from two handwheels to a motor control unit and thence to two hydraulic motors.

Without any necessity of redesigning the equipment, 4 standard S.S.White flexible shafts were used in place of the original control system. The result was a 90% savings — and, incidentally, 100% improved performance.

What About Your Application?

Perhaps your own designs cannot realize benefits as outstanding as this. But the chances are good indeed, that, if you are not now using them, you'll be able to handle many remote control and power drive applications better and at less cost with an S.S.White flexible shaft.

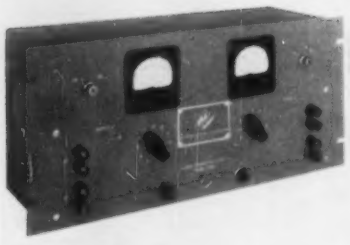
USEFUL FLEXIBLE SHAFT DATA

Bulletin 5601 has concise information on how to select and apply flexible shafts. Send for a copy.

F6-2

S.S.White FIRST NAME IN FLEXIBLE SHAFTS

S. S. WHITE INDUSTRIAL DIVISION, DEPT. E, 10 EAST 40th ST., NEW YORK 16, N.Y.
Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.



oratory and industrial power requirements.

► **Specifications**—The supply operates from a 95-125 v a-c, 60-cps source. Either output can provide singly or simultaneously 0-30 v d-c at a maximum current of 1.5 amperes. Ripple is less than 0.05 percent. Input regulation is better than ± 1 percent, and the internal d-c resistance is less than 3 ohms. The shunt a-c impedance is less than 0.02 ohm at 60 cps. In addition to the d-c outputs, line regulated a-c output 0-130 v a-c is also provided.

INDICATOR LIGHTS
two-terminal subminiatures

HETHERINGTON INC., Sharon Hill, Pa., has announced fully insulated, two-terminal indicator or warning lights in the smallest sizes consistent with the dependability required for aviation and critical industrial applications. They are available in two basic styles—series L-3100 subminiature design measuring 1 11/16 in. long by 3/8 in. in diameter; and the L-3200, 1 5/8 in. long by 1/2 in. in diameter with a built-in press-to-test circuit for ultracritical warning light applications. The lamp circuit is fully insulated from the case in both types.

Miniature AN-3140 lamps are mounted deep inside a long plastic lens. An inside leveling of the lens serves to pipe the light

AIRBORNE ELECTRONICS AND WEAPON CONTROL SYSTEMS

Denver manufacturing plant now under design

Infrared laboratory

Instrumentation laboratory

Initial unit of flight test facility

Communications pilot line production

Simulators in computing center

At Ramo-Wooldridge today there exists a wide range of projects intended to aid aircraft in navigating to the vicinity of targets, finding the targets, destroying them, and returning safely to base. Work is under way in such fields as infrared and microwave detection, information display, communication and navigation, and analog and digital computing. Some projects are in the laboratory development stage, some in the flight test stage, some in pilot production.

Good progress is being made in the establishment of facilities and operational patterns that are well tailored to the unique requirements of advanced electronic systems work.

Positions are available for scientists and engineers in these fields of current activity:

Communications Systems
Digital Computers and Control Systems
Airborne Electronic and Control Systems
Electronic Instrumentation and Test Equipment
Guided Missile Research and Development
Automation and Data Processing
Basic Electronic and Aeronautical Research

The Ramo-Wooldridge Corporation

8730 ARBOR VITAE STREET LOS ANGELES 45, CALIFORNIA

RADIO INTERFERENCE AND FIELD INTENSITY *measuring equipment*

Stoddart equipments are suitable for making interference measurements to one or more of the following specifications:

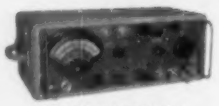
AIR FORCE—MIL-I-6181B
150 kc to 1000 mc
BuAir—MIL-I-6181B
150 kc to 1000 mc
BuShips—MIL-I-16910A (Ships)
14 kc to 1000 mc
SIGNAL CORPS—MIL-I-11683A
150 kc to 1000 mc
SIGNAL CORPS—MIL-S-10379A
150 kc to 1000 mc

The equipments shown cover the frequency range of 14 kilocycles to 1000 megacycles.

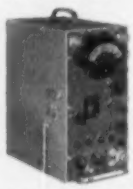
Measurements may be made with peak, quasi-peak and average (field intensity) detector functions.

F.C.C. PART 15—Now in effect, the revised F.C.C. Part 15 places stringent requirements upon radiation from incidental and restricted radiation devices. Stoddart equipment is suitable for measuring the radiation from any device capable of generating interference or c-w signal within the frequency range of 14 kc to 1000 mc.

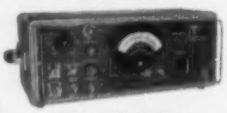
Write Stoddart Aircraft Radio Co., Inc., for your free copy of the new revised F.C.C. Part 15.



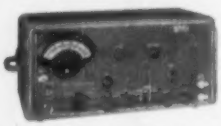
NM-10A (AN/URM-6B)
14 kcs to 250 kcs



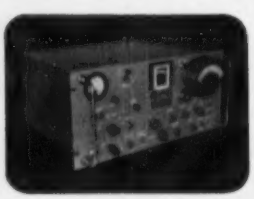
NM-20B (AN/PRM-1A)
150 kcs to 25 mcs



NM-30A (AN/URM-47)
20 mcs to 400 mcs



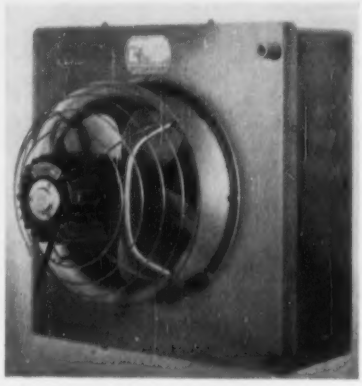
NM-50A (AN/URM-17)
375 mcs to 1000 mcs



The **Stoddart NM-40A** is an entirely new radio interference-field intensity measuring equipment. It is the commercial equivalent of the Navy type AN/URM-41 and is tunable over the audio and radio frequency range of **30 CPS to 15 kc.** It performs vital functions never before available in a tunable equipment covering this frequency range. Electric and magnetic fields may be measured independently over this range using newly developed pick-up devices. Measurements can be made with a 3 db bandwidth variable from 10 CPS to 60 CPS and with a 15 kc wide broadband characteristic.

STODDART *Aircraft Radio Co., Inc.*
6644-A SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA · Hollywood 4-9294

throughout the entire periphery, thereby assuring maximum visibility from all angles. The heavy lens is over ½ in. long so the lights may be used equally well with either standard or edge-lit panels.



HEAT EXCHANGER
used in liquid circuits

ROTRON MFG. Co., Schoonmaker Lane, Woodstock, N. Y. Recommended for use in closed-system liquid circuits, the model A heat exchanger has 3-kw capacity and finds application in radio transmitters, oscillators, dielectric heating apparatus, and similar devices incorporating liquid-cooled vacuum tubes.

► **Capacities**—The exchanger, weighing 12 lb, is available in either type 1-3000 having liquid flow capacity of 4 gpm or type 2-3000 having liquid flow capacity of 8 gpm. Heat capacity is the same for each type.

The fan motor is of the shaded-pole type and connects to a 1-phase, 115-v, 60-cps supply line. Catalog sheet 80201-1 is available.

CONTROLLED WARMUP TUBES
feature high perveance

GENERAL ELECTRIC CO., Schenectady 5, N. Y. A new horizontal deflection amplifier tube, the 12DQ6, has been added to the company's line of 600-ma controlled warmup tubes. Also now available is the 6-v version, the 6DQ6.

Both tubes have extremely high perveance, permitting the design of

1100-cm/μsec writing rate!

Arrow indicates 1100-cm/μsec writing-rate point on 100-mc damped oscillation, displayed on single 0.01 μsec/cm sweep of Type 517A Oscilloscope with T54P11H crt. Recorded on 35-mm TRI-X film at f 1.9 with 4.2 to 1 reduction, developed 26 minutes in D-19 at 68° F.

The Tektronix Type 517A Cathode-Ray Oscilloscope has the high writing rate, faithful transient response, fast sweeps, and dependable stability necessary for accurate analysis of single high-speed occurrences. Improvements in several performance areas, made possible by the development of a new Tektronix high-voltage cathode-ray tube, make the Type 517A even more useful than its famous predecessor, the Type 517. Sensitivity of the Type 517A is double that of the Type 517, both sweep and vertical linearity are improved, and the viewing area is increased to a full 4 cm by 8 cm. An automatic duty-cycle limiter prevents accidental damage to sweep-circuit components. The exceptional performance characteristics and accurate display of the Type 517A can speed up progress in work involving high-speed transients.

Price $3500

f.o.b. Portland (Beaverton), Oregon

Includes indicator unit, power-supply unit, scope-mobile, cathode-follower probe, 7-step attenuator unit, viewing hood, bezel, 170-ohm cable.

Complete specifications and information on demonstration schedules are available from your local Tektronix Field Office or Representative, or from...

Transient Response—Risetime seven millimicroseconds.
No overshoot or ringing.

Maximum Sensitivity —0.05 v/cm.

Sweep Range—Eleven calibrated sweeps
from 0.01 μsec/cm to 20 μsec/cm. Each can be adjusted to the accuracy of an external standard.

Regulated Accelerating Potential—
24 kv on T54P11H Tektronix metallized precision cathode-ray tube.

Low Displacement Error—
Less than 1% of 8 cm horizontal, less than 2% of 2 cm vertical.

Rate Generator—
15 to 15,000 cycles, accurate within 5% of full scale.

Amplitude Calibrator—
Pulse-type, accurate within 4% of full scale.

Regulation—
All dc supplies electronically regulated. Indicator-unit heater voltages regulated.

Calibrated Horizontal-Position Vernier

Tektronix, Inc.

P. O. BOX 831, PORTLAND 7, OREGON
CYpress 2-2611 • Cable: TEKTRONIX

Where dependability is vital...

METEX RF SHIELDING CONTROLS RADIO NOISE!

In radar systems — as in all types of noise-sensitive electronic devices — more and more design engineers are turning to METEX RF Shielding Products as the most practical and effective method of suppressing radio noise.

METEX Shielding Materials are formed from *knitted*, metallic wire for maximum *conductivity*. The inherent *resiliency* of the knitted structure provides a continuous line contact between imperfect mating surfaces with minimum contact impedance. The countless, interlocked loops, formed from continuous wire strands, impart maximum *cohesion* with no loose strands or frayed fibres.

This unique combination of electrical and mechanical properties not only re-establishes electrical conductivity across joints, but conforms to wide irregularities in mating surfaces with minimum closing pressure.

METEX Electronic Weatherstrip, RF Gaskets and Combination Fluid and RF Sealing Gaskets are available in a wide variety of types and sizes to solve your RF noise problems. Write for full information *today!*

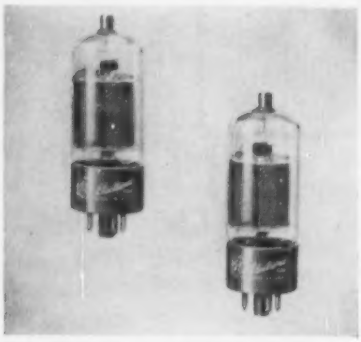
Send for your copy of this fact-filled METEX Handbook NOW!

6-063

ELECTRONICS DIVISION

METAL TEXTILE CORP.

ROSELLE • NEW JERSEY



high-efficiency 90-deg deflection systems without the necessity of using an expensive deflection amplifier tube.

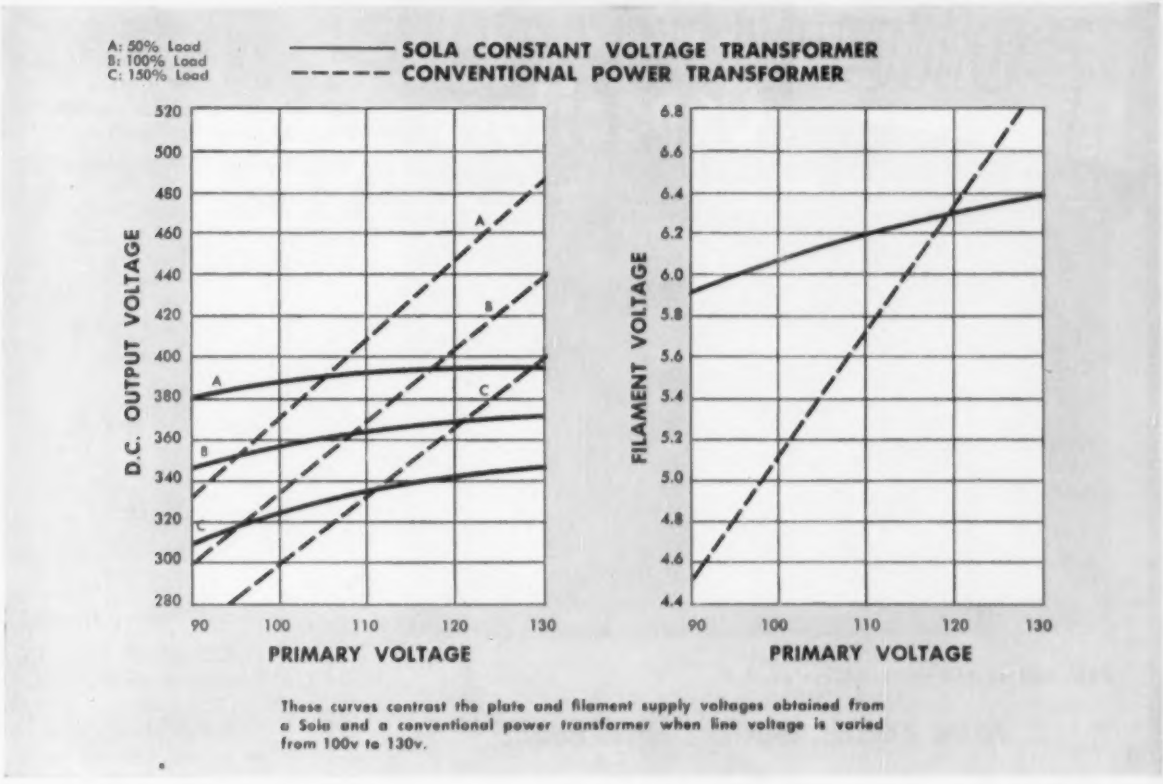
► **Other Technical Data**—They incorporate 6,000-v pulse capability, a 15-w dissipation rating and a large bulb for increased reliability. The 6DQ6 heater is rated at 6.3 v and 1.2 amperes. The 12DQ6 has a 12.6-v rating at 600-ma current with an 11-sec warmup time.

A-C REGULATOR
dual-voltage automatic type

ELECTRONIC MEASUREMENTS CO., Lewis St., Eatontown, N. J. Model 260-A automatic a-c regulator operates for either 115 or 230-v mains without derating. Voltage changeover is accomplished in the field by simple switching devices requiring only seconds to operate.

► **Specifications**—The control tolerance is better than 1 percent; and power rating is 6 kva, and input range is 100 to 130 or 200 to 260 v at line frequencies from 47 to 63 cycles.

The unit also features a monitor which warns of improper operation plus a fail-safe arrangement to prevent over-voltage. Wall or floor-



These curves contrast the plate and filament supply voltages obtained from a Sola and a conventional power transformer when line voltage is varied from 100v to 130v.

Improve Performance of electronic products with built-in regulating power transformer

You can make sure your product will always receive correct plate and filament voltages by building in a Sola Constant Voltage Power Transformer (Type CVE) in place of a conventional, non-regulating power transformer.

The Sola CVE provides ±3% regulation of plate and filament supply, with line voltage variations of 100 to 130 volts. Regulation is completely automatic, continuous and substantially instantaneous (1.5 cycles or less). Sola CVE stabilizers have no moving parts or tubes, require no manual adjustments or maintenance, and are self-protecting against short circuits.

Three stock units (all with high voltage ct, 5.0v and 6.3v regulated windings) are stocked by your electronic distributor. You can order production quantities of special units manufactured to your specification. We invite your inquiry.

TYPICAL STOCK UNIT: Sola Electronic Power Transformers are made for chassis mounting. They are furnished complete with separate capacitors and capacitor mounting brackets.

Automatic, Maintenance-Free Voltage Stabilization

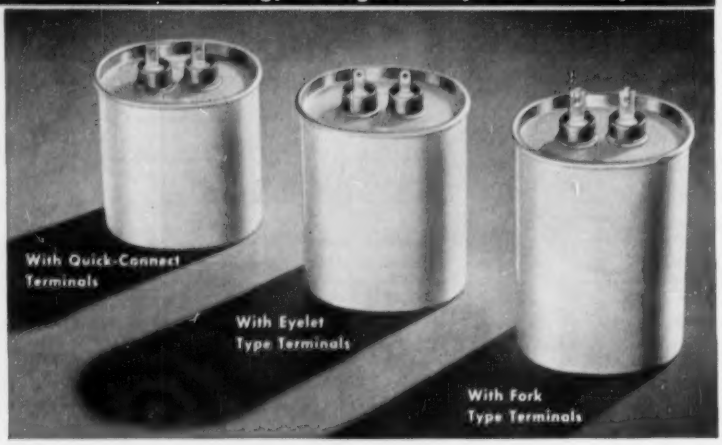
SOLA *Constant Voltage* TRANSFORMERS

SEND FOR FOLDER:
Please write for folder which gives complete data.
Ask for CIRCULAR 7D-CVE-195

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • **LIGHTING TRANSFORMERS** for All Types of Fluorescent and Mercury Vapor Lamps. • **SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414** • *NEW YORK 35: 103 E. 125th St., TRafalgar 6-6464* • *PHILADELPHIA: Commercial Trust Bldg., Rittenhouse 6-4988* • *BOSTON: 272 Centre Street, Newton 58, Mass., Bigelow 4-3354* • *CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400* • *KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382* • *LOS ANGELES 23: 3138 E. Olympic Blvd., ANgelus 9-9431* • *TORONTO 17, ONTARIO: 102 Laird Drive, Mayfair 4554* • *Representatives in Other Principal Cities*

potter AC DRAWN OVAL Capacitors

For Air Conditioning, Refrigeration, Fan Motors, etc.



236, 330 or 440 volts, 60 cycles, A.C.

...save space, weight and cost!

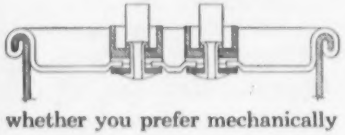
LEAK PROOF CONSTRUCTION:

Cases are seamless, and tops (see drawing) are joined to cases via a double-rolled seam which provides not only a perfect and permanent seal but also incorporates exceptional mechanical strength. No solder is needed or used.

SPECIAL IMPREGNANT:

Cases are filled with Chlorinated Diphenol Resin — an impregnant which is non-flammable and has high dielectric qualities. It has exceptional stability and long life, even at high operating temperatures.

CHOICE OF TERMINALS:

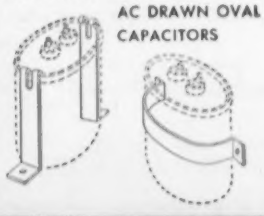


Three types of terminals, (see illustration) to fit your particular needs—speed connecting time whether you prefer mechanically joined or soldered leads.

WIDE RANGE OF SIZES:

Available for 236, 330 and 440 volts A. C., 60 cycles. Conventional or barrier type terminal mounting. Two types of mounting brackets.

MOUNTING BRACKETS FOR THE AC DRAWN OVAL CAPACITORS



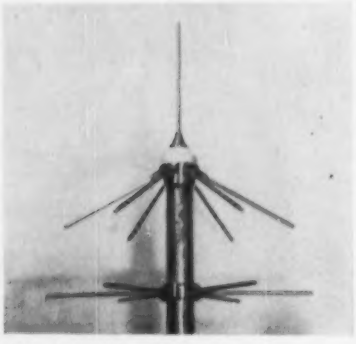
Write for Bulletin 237 A

THE potter COMPANY

Specialists in Fixed Paper Capacitors Since 1925

1950 SHERIDAN ROAD, NORTH CHICAGO, ILL.

mounted it is 18½ in. high by 13 in. wide by 8¾ in. deep overall. A rack unit is also available having dimensions of 19 in. by 8¾ in. by 13 in. deep. The weight is 90 lb.



NEW ANTENNA
for communications purposes

THE HERB KRECKMAN ANTENNA CO., 124 Greenwood Drive, Massapequa, N. Y., announces a new series of communications antenna designed to mount directly on 1¼ in. support pipe. The DGP-155 is an all-brass duo-ground plane which has 6 radials for improved impedance to frequency characteristics.

Also in the new series are coaxial, co-plane and a 4-element stacked coaxial for the 108 to 470-mc range; and coaxial, co-plane, ground plane and duo-ground planes for the 25 to 50-mc range.

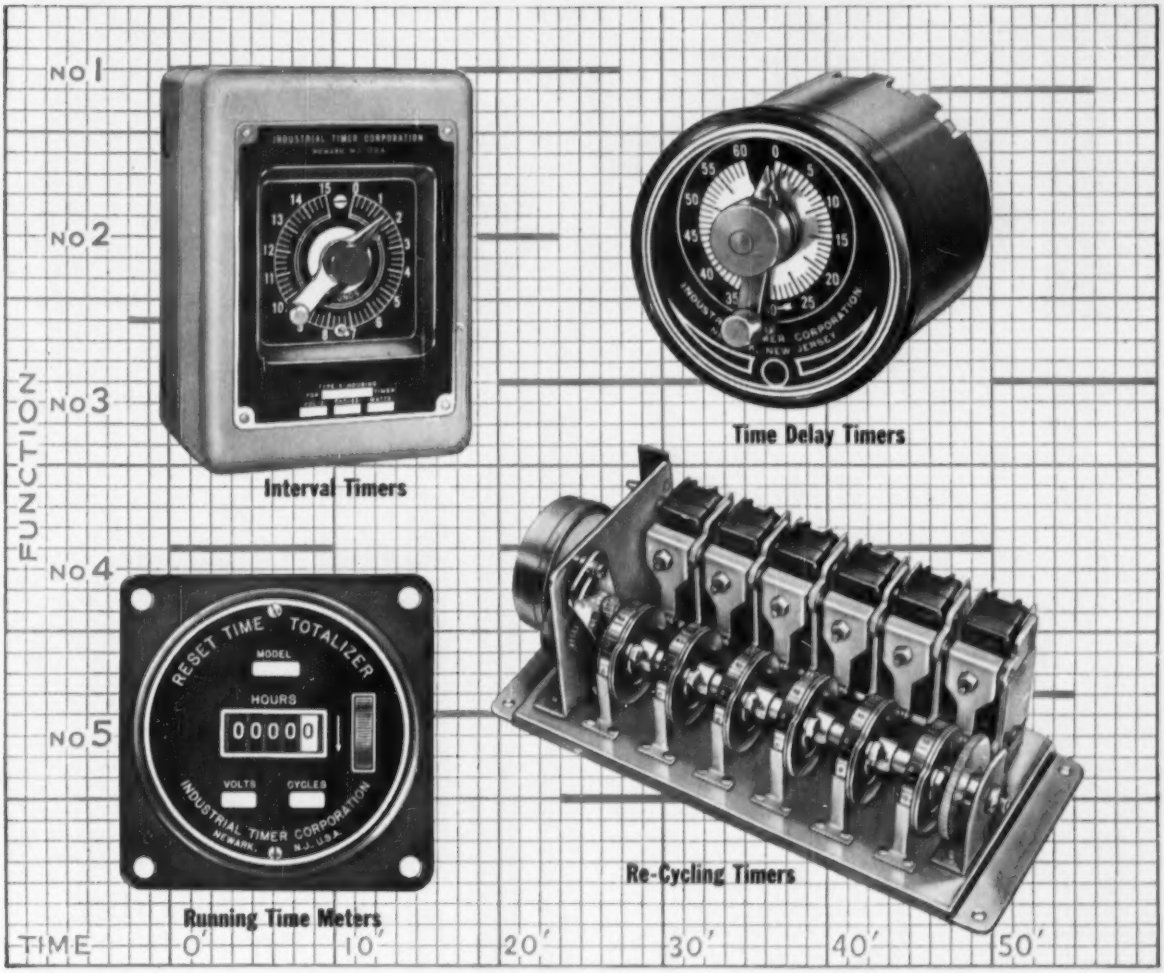
At 40 mc the new series of coaxials and ground-planes will withstand winds in excess of 100 mph.

SECONDARY STANDARDS
available in 38 ranges

PHAOSTRON INSTRUMENT AND ELECTRONIC CO., 151 Pasadena Ave., South Pasadena, Calif. A new line of completely self-contained, ready-to-use, portable laboratory instruments (secondary standards) are available in 38 standard ranges. Rated accuracy is either 0.5 percent or 1 percent of full scale deflection. An incorporated overload network provides meter protection up to 500 times full scale value for short periods.

► **Switch**—Multirange portable instruments are available which pro-

YOUR "SPECIAL" TIMER
may be one of our
721 STANDARD UNITS!



We have 20 years of experience in developing new timers to meet our customers' widely varying requirements. Our Engineering Department not only originates new designs, but also develops modifications for that purpose. That's why most requests for special timers can be filled without delay—by one of the 721 combinations we've developed so far from our 17 basic types of timers. But if we don't have what you want on hand, we'll welcome the chance to design and make it for you! And quickly too!

We manufacture a complete line of timers in these 4 broad classifications:

INTERVAL TIMERS • TIME DELAY TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

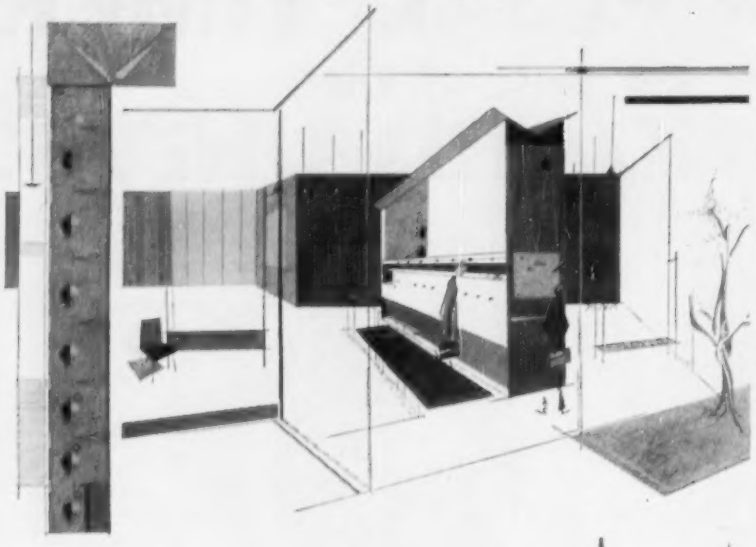
Our large stock assures you of rapid deliveries—even when we have to create a brand new timer for your special needs. Ask us first—you may save yourself much lost motion . . . and your inquiry will receive prompt attention.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

1409 McCARTER HIGHWAY, NEWARK 4, N. J.

MARS outstanding design **SERIES**

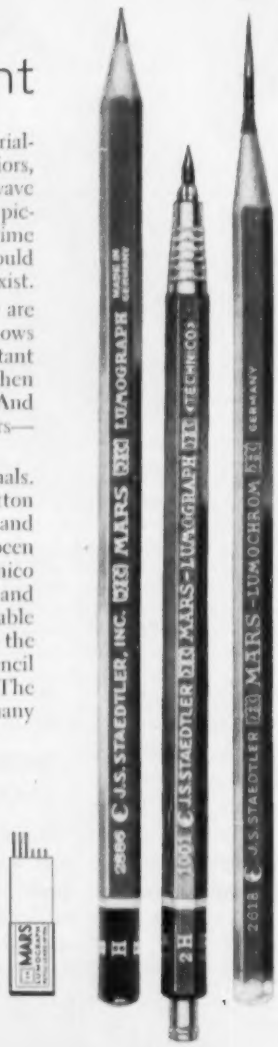


chef-less restaurant

This concept of Sue Vanderbilt, Pratt industrial-design graduate now designing GM auto interiors, would assemble a whole meal and cook it by microwave in a few seconds. Customer would merely check picture menu, insert money, push buttons. By the time he reached the far end of the counter the meal would be waiting, piping hot. All components already exist.

Many designs that will make news tomorrow are still in the "bright idea" stage today. No one knows which will flower into reality. But it will be important in the future, as it is now, to use the best of tools when pencil and paper translate a dream into a project. And then, as now, there will be no finer tool than Mars—sketch to working drawing.

Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and — last but not least — the Mars-Lumochrom, the new colored *drafting* pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.



The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom colored *drafting* pencil, 24 colors.

J.S. STAEDTLER, INC.
HACKENSACK, NEW JERSEY

at all good engineering and drawing material suppliers

vide up to 6 ranges with a multiplier switch. This switch also protects the meter movement when set in transit position by damping the meter movement and thereby giving additional protection during storage and transit.

Specifications, including leather carrying case, are: height, 7½ in.; width, 6⅝ in.; and depth, 3¾ in.

H-V RECTIFIER TUBE
cuts tv manufacturing costs

GENERAL ELECTRIC CO., Schenectady 5, N. Y. The 2B3-GT h-v rectifier tube promises to cut tv set manufacturing costs and give longer life.

▶ **Specifications**—It has a filament rating of 1.75 v at 0.25 ampere as compared with the 1.25-v and 0.2-ampere rating of the 1B3-GT. The tube can be operated directly from the flyback transformer without a filament dropping resistor—thus saving the manufacturer the cost of the resistor, associated wiring and assembly expense.

The 2B3-GT has a new type of filament construction which promises to give longer life and greater

Indiana Permanent Magnets

undergo **13** *quality and uniformity tests!*

. . to help maintain a steady flow on YOUR production line

. . to help reduce rejects on YOUR final product assemblies

World's Most Complete Line of Permanent Magnets!

all shapes . . all sizes . . all grades . . cast Alnico . . sintered Alnico . . Hyflux Alnico V . . ceramic Indox . . Cunife . . and other special magnet materials

Yes, Indiana Permanent Magnets undergo a wide range of tests . . Spectograph tests . . chemical analyses . . Zyglo tests . . 13 tests in all to assure precise magnetic characteristics, sound structure, exact physical dimensions . . in short, to assure uniformity and high quality.

Maintaining the high quality of Indiana Permanent Magnets is not just a one-man or one-department responsibility. Teams of physicists, engineers, technicians and experienced craftsmen supervise and keep a constantly critical eye on all stages of production. Quality control is this group's most important single job . . by far!

To be sure of better permanent magnets, take advantage of the experience of permanent magnet specialists. Indiana maintains the World's largest staff of engineers devoted solely to the design and application of permanent magnets . . the World's largest and most complete research and production facilities.

Indiana engineers, with almost a half century of experience in "tailoring" permanent magnets for more than 35,000 designs, will welcome the opportunity to work with your technical men in the development of your permanent magnet designs.

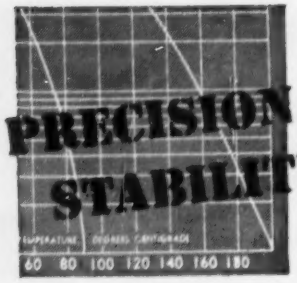
We invite you to contact your nearest Indiana sales engineer . . in Boston, HAncock 6-2323 . . in Chicago, FRanklin 2-1114 . . in Cleveland, CHerry 1-4163 . . in New York, VAnderbilt 6-1898 . . in Los Angeles, DUnkirk 4-0465 . . in Philadephia, KIngsley 5-2036 . . in Rochester, HAmilton 8990.

Write, today, for your copy of magnet catalog #11-A4. This 8-page booklet details the wide range of Indiana cast permanent magnets available for immediate delivery in sample quantities.

. . Manufacturers of permanent magnets for the electronics, electrical, instrument and communications industries

THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA
World's Largest Manufacturer of Permanent Magnets

INDIANA PERMANENT MAGNETS



Signposts of Quality that make F.C.I. Capacitors ideal for exacting applications.

POLYSTYRENE and TEFLON CAPACITORS
For applications where the ultimate in low power factor, low soakage, high IR, and high capacitance stability are of vital importance. Voltage ranges from 100 V up; operating temperatures to 85° C for Polystyrene; to 200° C for Teflon.

ADJUSTABLE CAPACITORS
Designed for circuits requiring large capacitances at close tolerance. They provide instantaneous capacitance changes without subsequent drift. Adjustments can be made within ±1.5% of nominal value. Non-inductive windings minimize power factor and soakage. Electrical characteristics same as fixed polystyrene capacitors.

HIGH VOLTAGE CAPACITORS
Employ a "high-breakdown" plastic film producing capacitors remarkably smaller and lighter than previously available. Operation at temperatures to 125° C, with voltages from 2 to 60 KV. Hermetic glass tube housings with wire leads or threaded stud mountings.

MINIATURE CERAMIC CAPACITORS
Mylar* dielectric capacitors housed in ceramic jackets with thermosetting plastic end fill. Specially impregnated to minimize temperature coefficient. Insulation resistance is maintained under the most severe conditions of temperature and humidity.

*Du Pont trademark

ELECTRICAL CHARACTERISTICS

	POLYSTYRENE	TEFLON	H.V.	MINIATURE MYLAR
Operating Temp. Range	−55°C to +85°C	−55° to +200°C	−55°C to +125°C	−55° to +125°C
Voltage Range, D.C.	100 to 30,000	100 to 30,000	600V to 60KV	100-600V
Capacitance Range	.001 to 20 MF	.001 to 20 MF	.0001 to 0.1 MF	.0001 to 1.0 MF
Power Factor	.02% @ 1KC	.02% @ 1 KC	0.3% @ 1 KC	0.3% @ 1 KC
Dielectric Absorption:	.01%	.01%	0.1%	0.1%
Voltage Operating at 85°C	none	none	30%	none
Voltage Derating at 125°C	not operable	none	66%	30%
Voltage Derating at 150°C	not operable	none	not operable	not operable
Voltage Derating at 200°C	not operable	33%	not operable	not operable
Temperature Coefficient	−100 PPM/°C	−100 PPM/°C	+500 PPM/°C	+60 PPM/°C up to 70°C
I.R. at Room Temperature	10^7 megohms/MF	10^7 megohms/MF	10^5 megohms/MF	10^5 megohms/MF
Capacitance Stability	0.1%	0.1%	0.5%	0.2%

When your industrial capacitors specs. call for precision and stability, specify FCI.
Excellent delivery on standard or special types—Capacitors made to your specifications.
For more complete technical data, write for catalog.

fci **film capacitors, INC.**
3400 Park Avenue, N.Y., N.Y. • Telephone CYpress 2-5180

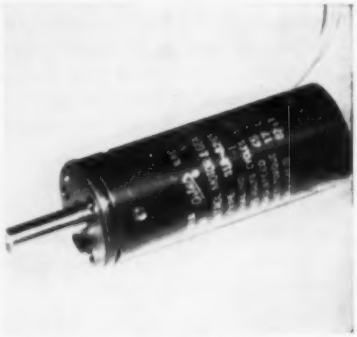
dependability. Other ratings and pin connections remain the same as the 1B3-GT.

D-C AMPLIFIER
for lab and portable use

THE RALPH M. PARSONS CO., 135 W. Dayton St., Pasadena, Calif., has designed a d-c amplifier to meet the exacting requirements of data recording in both laboratory and portable applications. Gain is adjustable to a maximum of 400 with drift not exceeding 2 in. in any half-hour period.

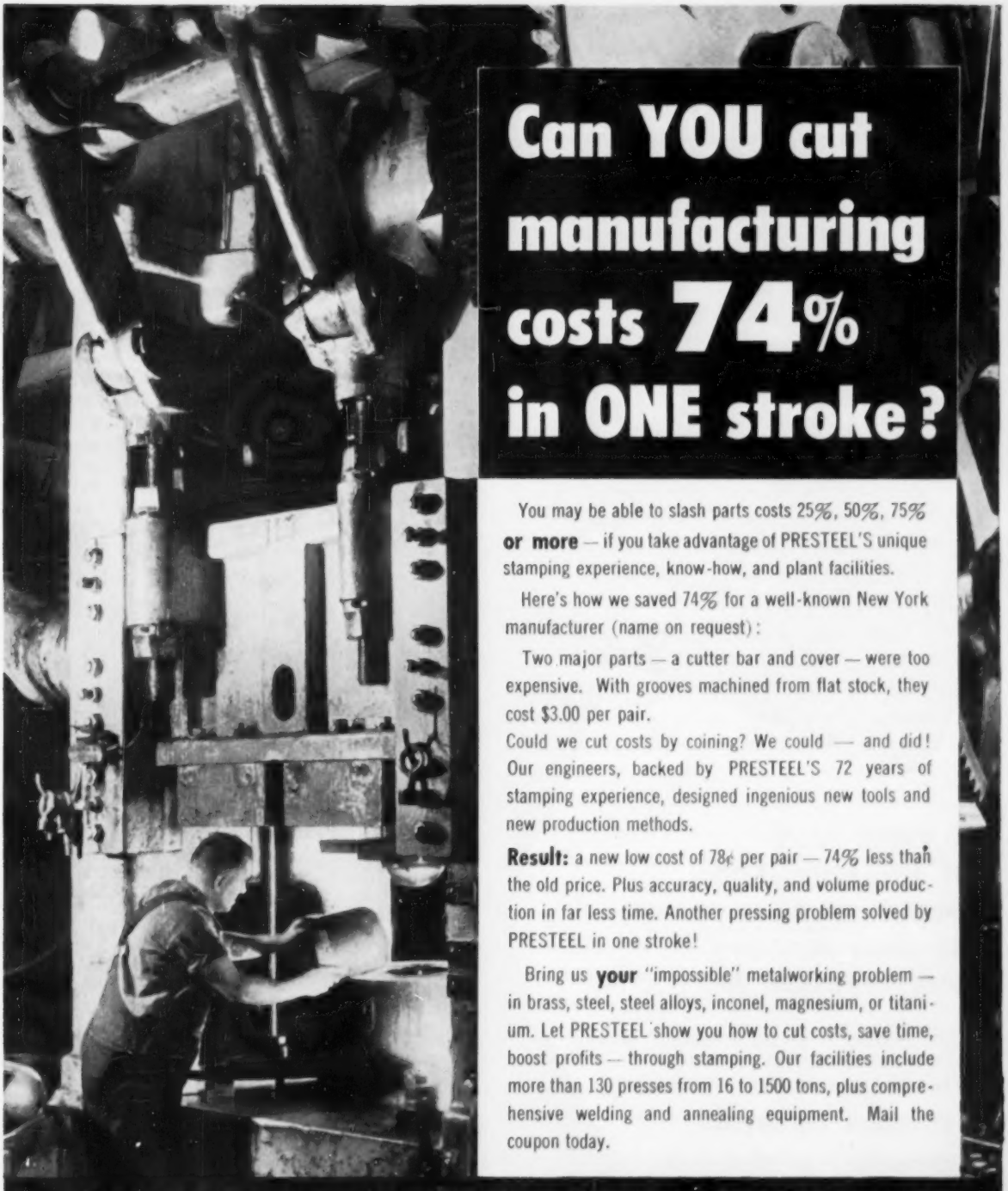
The amplifier is free of oscillations regardless of the gain balance or compensator setting. A control is provided to compensate for the response characteristics of the recorder which may be used. Any standard pen or graphic recorder may be used.

For further information write for bulletin 119.



SERVO GEAR TRAIN
weighs only 6.875 oz

JOHN OSTER MFG. CO., Racine, Wisc., has available a new size 11 servo gear train weighing only 6.875 oz and consisting of a single



Can YOU cut manufacturing costs 74% in ONE stroke?

You may be able to slash parts costs 25%, 50%, 75% **or more** — if you take advantage of PRESTEEL'S unique stamping experience, know-how, and plant facilities.

Here's how we saved 74% for a well-known New York manufacturer (name on request):

Two major parts — a cutter bar and cover — were too expensive. With grooves machined from flat stock, they cost $3.00 per pair.

Could we cut costs by coining? We could — and did! Our engineers, backed by PRESTEEL'S 72 years of stamping experience, designed ingenious new tools and new production methods.

Result: a new low cost of 78¢ per pair — 74% less than the old price. Plus accuracy, quality, and volume production in far less time. Another pressing problem solved by PRESTEEL in one stroke!

Bring us **your** "impossible" metalworking problem — in brass, steel, steel alloys, inconel, magnesium, or titanium. Let PRESTEEL show you how to cut costs, save time, boost profits — through stamping. Our facilities include more than 130 presses from 16 to 1500 tons, plus comprehensive welding and annealing equipment. Mail the coupon today.

WORCESTER PRESSED STEEL COMPANY

FREE!

from Worcester Pressed Steel, this handsome, practical ashtray — an example of PRESTEEL craftsmanship — is yours for the asking. Attach the coupon to your business letter head.

Get a quote from the leader — PRESTEEL!

101-D Barber Ave., Worcester 6, Mass.

Please send me a PRESTEEL ashtray and brochure illustrating facilities and products.

Name _____

Title _____ Company _____

Street _____

City _____ Zone _____ State _____

Fine Tubing
CUT and FORMED
TO ENGINEERING SPECIFICATIONS

IN THESE DAYS
OF MINIATURIZATION
SPECIFY SEAMLESS TUBING
CUT AND FORMED
WITH PRECISION FOR....

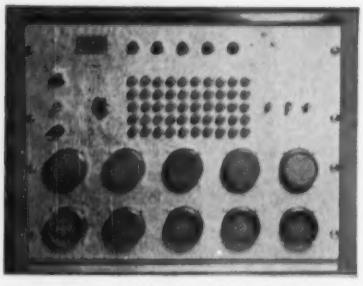
★ BUSHINGS ★ COMPONENT PARTS
★ LEADS ★ FEED-THROUGHS
★ CONTACTS ★ EYELETS
★ CATHODES ★ TERMINALS
★ SPACERS ★ ANODES

Send Your Prints For Quotation.

KLEINER METAL SPECIALTIES INC.
P. O. BOX 185, DUNELLEN, NEW JERSEY

homogeneous unit instead of two separate parts. Type 2LR-3265 is designed to meet military requirements and can be built to operate 150 C ambient. Both the motor section and the gear train section are extremely versatile and are designed to cover a great range of applications. For example, the motor can be made to operate as a 2, 4, 6 or 8-pole motor. Windings can be made to operate on 60 or 400 cycle, 26 to 115 v.

The gear train operates with load torques up to 25 in.-oz and maximum momentary load torques of 75 in.-oz. Backlash is 35 minutes minimum. Gear ratios may be varied in convenient steps from 12 to 1 to 4,000 to 1. A slip clutch is available if desired. Units have been made with windings to load output transformers of amplifiers or to be connected directly to the output tubes or transistors.



CONTINUITY TESTER
used on production lines

CENTURY ENGINEERS, INC., Burbank, Calif. Up to 200 conductors in groups of 50 in any given cable or harness assembly can be checked automatically with the new continuity tester.

► **Operation**—The tester uses stepping switches of the telephone variety to provide automatic switching from one circuit to another. The read-out is positive. Six volts d-c is used for test voltage. The tester, with appropriate patch cables, will check cables and harnesses.

The instrument is provided with the following front panel controls: power light, switch and fuse, momentary start switch and reset switch, 50 numbered lights for circuit identification, a ready light to

From 3 to 20 times the usual plotting area

. . . combined with considerably simplified operation

Direct plotting on the face of a 22-inch indicator is now possible through the use of our AN/SPA-23 (XN-1) indicator.

Developed for the Navy Department, this indicator uses a 22-inch flat-faced (250-inch radius) cathode ray tube permitting parallax-free observation and plotting. Through its size, several operators may be accommodated.

Incorporating a high degree of flexibility, ranges from 4 to 300 miles are provided and input repetition rates of 60 to 3000 PPS are accepted. All contents have been "human-engineered" for operator convenience and minimum fatigue.

Designed for maximum reliability and ease of maintenance, the unit may be completely serviced from the front with all components readily accessible and replaceable.

This indicator is but one of the many products designed and developed by Stromberg-Carlson for the defense of our country.

In military or civilian products of the highest order—there is nothing finer than a Stromberg-Carlson.

S-C

STROMBERG-CARLSON COMPANY

A DIVISION OF GENERAL DYNAMICS CORPORATION

General Offices at ROCHESTER 3, N. Y.

TO PROVIDE THE MISSING LINK

JK G-7

Miniaturized Precision Crystals, in a range from 1000 cycles to 150 mc, combining minimum size with maximum stability.

JK H-3

"Thermystal", an advance design frequency control unit that combines plug-in simplicity with extreme precision. Calibration accuracy: ± (1 cycle + .0001%). Temperature stability: 30 to 900 kc ± .0001%. 1000 kc to 150 mc .00005%.

JK-THERMYSTAL

Precision "Glasline" Crystals over a complete range of 800 cycles to 5 mc, including the JK G-12A with a proven stability of one part in one billion per day at 1000 kc.

JK G-12A

These recent JK product developments indicate the wide range of experience available to bear on your frequency management problems. Can you take advantage of these advanced James Knights developments? They are now available on a production basis.

THE JAMES KNIGHTS COMPANY

Crystals for the Critical

SANDWICH, ILLINOIS

JK PRODUCTS

indicate the starting position of the tester, lights 1 through 4 to indicate which group of 50 circuits is under test, positional selector switch to select the bank of 50 circuits to be tested.

TINY POTENTIOMETER
flexible or turret terminals

CIRCUIT INSTRUMENTS INC., P.O. Box 355, 1927 First Ave. South, St. Petersburg, Florida. Model HM-100 miniaturized multiturn potentiometer is available with either flexible or turret-type terminals. These potentiometers have a 1-oz-in. maximum starting torque, while net weight is only 1.2 oz.

▶ **Technical Data**—The unit is rated at 2 w at 40 C, and standard linearity is ±0.5 percent. Resistance values are from 500 to 100,000 ohms. Standard tolerance is ±5 percent; however, tolerances as low as ±0.5 percent can be obtained.

PRINTED CIRCUIT RECEPTACLE
in single or double rows

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. The 28-contact printed circuit receptacle (PCSC28) has a center barrier as part of the molding to provide extra strength and prevent warping. Gold-plated phosphor bronze contacts are available in single or double rows to accommodate up to 56 connections.

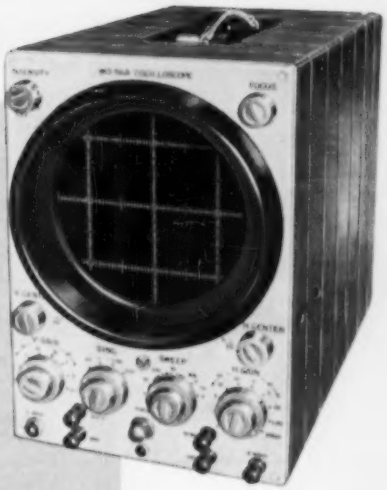
Exclusive Bellows-type contact with coil-spring action grip clasps board firmly over the entire printed circuit board contact area. It retains tension and allows use of

General-Purpose DIRECT-COUPLED 5" 'SCOPE, WO-88A

Low in cost, yet high in quality—for general laboratory applications, production-line alignment, testing, troubleshooting—built-in voltage-calibrating facilities permit simultaneous waveshape display and peak-to-peak voltage measurements; sync polarity instantly reversible; only 10 μμf input capacitance with probe.
Price **$169.50***

Identical "V" & "H" Amplifiers DIRECT-COUPLED 7" 'SCOPE, WO-56A

Invaluable for phase measurements or vector display—7" screen plus trace expansion of 3 times screen diameter provide unusually large waveshape display for distant viewing or close examination of minute portions of waveshapes; frequency-compensated voltage-calibrated attenuators in both "V" and "H" amplifiers.
Price **$274.50***



Economy-Priced DUAL-BAND 5" 'SCOPE, WO-91A

Excellent for general laboratory, or production-line for waveshape observation and measurement, signal tracing, and alignment of chrominance circuits and wide band amplifiers—voltage-calibrated input step-attenuators and calibrated graph screen make possible direct voltage readings as easily as with a VTVM.
Price..... **$229.50***

Engineer's Choice DUAL-BAND 5" 'SCOPE, WO-78A

Recommended to and chosen by engineers requiring a 'scope with extra-sensitivity and extended-frequency response—utilizes flat-faced cathode-ray tube with post-deflection acceleration; automatic sync limiting; push-button for calibration checking; excellent phase characteristics; full screen deflection over entire rated frequency range.
Price **$425.00***

CHOOSE FROM FOUR OF THE FINEST...

RCA OSCILLOSCOPES...

accurate, reliable instruments designed to operate with minimum maintenance under production conditions!

RCA Oscilloscopes and other superior-quality RCA Test Instruments are available through your RCA Distributor. See him now for early delivery. For detailed technical data, write RCA, Commercial Engineering, Section D-19-W, Harrison, N. J.

TEST EQUIPMENT
Radio Corporation of America, Harrison, N. J.

SPECIFICATIONS	WO-91A	WO-78A	WO-88A	WO-56A
FREQ. RESPONSE: Wide-Band Positions	10 cps to 4.5 Mc (±1 db)	3 cps to 4.5 Mc (−1 db)		
High-Sensitivity Positions	10 cps to 500 Kc (−1 db) 10 cps to 1.5 Mc (−6 db)	3 cps to 500 Kc (−3 db)	0 cps to 500 Kc (−3 db) 0 cps to 1 Mc (−10 db)	0 cps to 500 Kc (−2 db) 0 cps to 1 Mc (−6 db)
SENSITIVITY Wide-Band Positions	0.053 (rms) v 0.15 (p-p) v	0.035 (rms) v 0.1 (p-p) v		
High-Sensitivity Positions	0.018 (rms) v 0.05 (p-p) v	0.0035 (rms) v 0.01 (p-p) v	0.025 (rms) v 0.07 (p-p) v	0.01 (rms) v 0.03 (p-p) v
RISE TIME ("V" Amp.)	0.1 μsec. (4.5 Mc) 0.5 μsec. (1.5 Mc)	0.1 μsec. (4.5 Mc) 0.7 μsec. (1.5 Mc)	0.5 μsec.	0.35 μsec.
SWEEP FREQ.	10 cps to 100 Kc Plus preset "H" & "V"	10 cps to 100 Kc Plus preset "H" & "V"	15 cps to 30 Kc	3 cps to 30 Kc Plus preset "H" & "V"

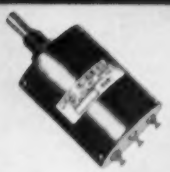
†volt/in. beam deflection measured at "V" amplifier input terminals.
*User Price (Optional). All instruments supplied with probes, cables, green graph screens, instruction booklets.

Want more information? Use post card on last page.

For Miniature Helical Potentiometers

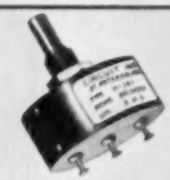
Call...

CIRCUIT INSTRUMENTS INC.



TYPES H-150 and H-155

Miniature 1½" diameter size. Turret type terminals. Rotation: Type H-150 3600, —0 +4°; Type H-155 1800, —0 +4°. Power rating 6 watts and 5 watts respectively. Patented stop mechanism completely separate from element and brush.

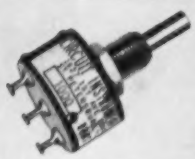


TYPE H-151

Only 1½" diameter x ¾", exclusive of shaft and turret terminals. Continuous rotation; stops available on special order. Standard linearity ±0.5%. Power rating 3 watts. Standard resistance values from 50 to 15,000 ohms. Weight 2 ounces.

TYPES H-100 and H-105

Slim 1" diameter. 5 and 10 turn types. Rotation: Type H-100 3600, —0 +4°; Type H-105 1800, —0 +4°. Power rating 4 watts and 3 watts respectively. Flexible silver plated terminals or rigid turrets available.



TYPE H-101

Tiny 1" diameter by ⅝", exclusive of shaft and turret terminals. Weight 1 ounce. Power rating 1½ watts. Standard resistance values from 50 to 10,000 ohms. Continuous rotation; stops available on special order

TYPES H-750 and H-755

Ultra-thin ¾" diameter size. Type H-750 3 watts, standard resistance values from 250 to 50,000 ohms. Type H-755, standard resistance values from 125 to 25,000 ohms. Either flexible silver plated terminals or rigid turrets available.

TYPE H-751

Small ¾" diameter by ⅜" body size, exclusive of shaft and turret terminals. Weight 1 ounce. Power rating 1 watt. Standard resistance values from 100 to 10,000 ohms. Continuous rotation; stops available on special order.

Note: Linearities (independent) can be supplied to ±0.1% for most resistance values.

SEND COUPON FOR SPECIFICATION SHEETS

Subsidiary of

IRC

INTERNATIONAL RESISTANCE CO.

CIRCUIT INSTRUMENTS INC.

P.O. Box 355
St. Petersburg, Florida

Send technical data sheets on the following Type H Potentiometers:

(_____) (_____) (_____) (_____)

Name_____

Address_____

City_____ State_____

undersized or oversized board while maintaining low contact resistance.

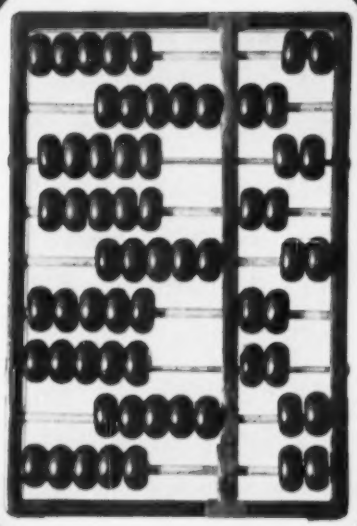
► **Special Design**—The PCB20 printed circuit receptacle is a special design type with center mounting and two sets of five double row contacts. It accommodates two printed circuit boards, each with 10 connections.

These connectors can be supplied in mineral filled Melamine, Plaskon reinforced (glass) alkyd type 440A and Orlon filled diallyl phthalate molding compounds.

COLOR TV TUBESCOPE
checks pattern accuracy

EDMUND SCIENTIFIC CORP., Barrington 3, N. J. The color tv tubescope is a microscope designed to assist and simplify alignment of the dot pattern on the picture tube during manufacture and field servicing. It checks the accuracy and concentricity of the pattern where unaided vision is unsatisfactory, inadequate and time consuming.

► **Parts**—The instrument consists of two parts, a main chrome-plated optical body housing a cemented



EARLY CHINESE ABACUS

The most powerful force known to science is that of a new idea.

Anon.

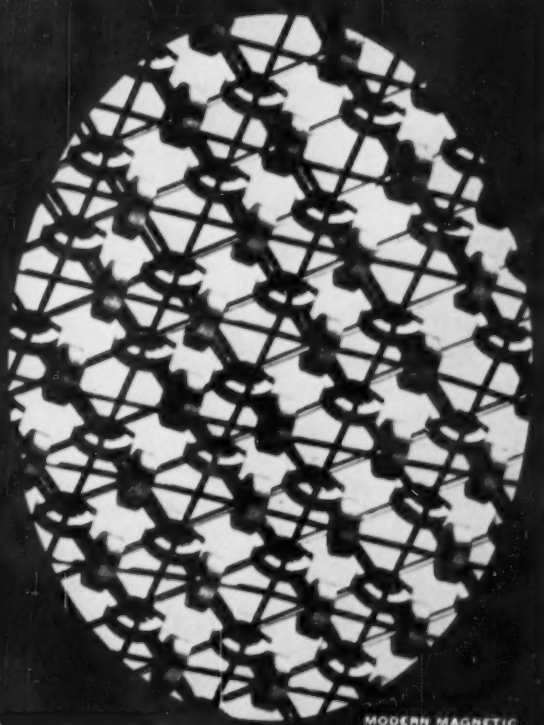
• If you, as an engineer, have a profound respect for new ideas

. . . if your search for them carries you beyond the arbitrary boundaries of your specific assignment

. . . and if, above all, you believe deeply in the irresistibility of the impact of ideas—

IBM's creative leadership in digital computer development, design and manufacture offers you a means to tremendous professional satisfaction.

For the specifics of the opportunity IBM offers you, write, outlining your background and interests, to:
Wm. M. Hoyt, Room 404, IBM, 590 Madison Avenue, New York 22, N. Y.



MODERN MAGNETIC CORE MEMORY

IBM®

INTERNATIONAL BUSINESS MACHINES CORPORATION

DATA PROCESSING · ELECTRIC TYPEWRITERS · TIME EQUIPMENT · MILITARY PRODUCTS

BIRD Model 43 Thruline DIRECTIONAL WATTMETER

Reads Directly . . . **WATTS FORWARD**

WATTS REFLECTED *. . . In 50 Ohm Coaxial Lines*

Measures POWER into the antenna in the actual operating circuit. Continuous monitoring if desired.

Measures reflected power, direct reading. In antenna matching work, results show directly in lower reflected power.

Ideal for mobile equipment.

Tests 50 ohm r-f lines, antenna connectors, filters—quickly.

ACCURATE because of high directivity and small frequency error.

DIRECT READING – no calibration charts, no full scale meter adjustments needed. Meter scale reads directly for all ranges and is expanded for better down-scale reading.

CONVENIENT – does not require reversal of r-f connections. No auxiliary power required.

Negligible power loss and insertion VSWR.

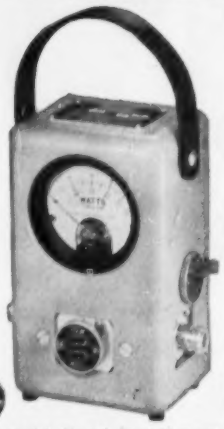
Full scale power range and frequency range are determined by the selection of plug-in elements from the following list.

Frequency Range—25-1000 megacycles in five ranges viz. 25-60 (A), 50-125 (B), 100-250 (C), 200-500 (D), 400-1000 (E).

Power Range—10, 25, 50, 100, 250, and 500 watts full scale. Available in most frequency ranges.

Accuracy – 5% of full scale.

Write for literature.



Model 43 with front element in operating position. Dimensions: 7" x 4" x 3" Weight, 4 pounds.

SO239 jacks for PL259 plugs available.

BIRD ELECTRONIC CORP.

1800 EAST 38TH ST., CLEVELAND 14, OHIO

TERMALINE Coaxial Line Instruments

VAN GROOS COMPANY
Sherman Oaks, Cal.

J-V-M MICROWAVE COMPONENTS

CUSTOM . . .

Cavities, duplexers, couplers, feed horns, mixers, rotating joints and other complex mechanical assemblies built to your specifications . . . Engineering service available . . . prompt quotations and deliveries.

STANDARD . . .

Straight lengths, flanges, bends, twists, attenuators, loads, xtal mounts, couplers, tees, etc., from stock.

WRITE FOR CATALOGUE TODAY!

J-V-M Engineering Co.

8847 W. 47th ST., BROOKFIELD, ILLINOIS

achromatic objective lens with the eyepiece, and the outer black anodized felt-lined aluminum barrel for focusing.

A working distance of 4¼ in. is ample to view the periphery of the tube, and make it unnecessary to remove the safety glass shield thereby protecting technicians from the high potential on the tube.

Five different eyepieces are available and can be easily interchanged to give powers from 10X to 33X. The instrument is 7¼ in. long with outside diameter of 1½ in.

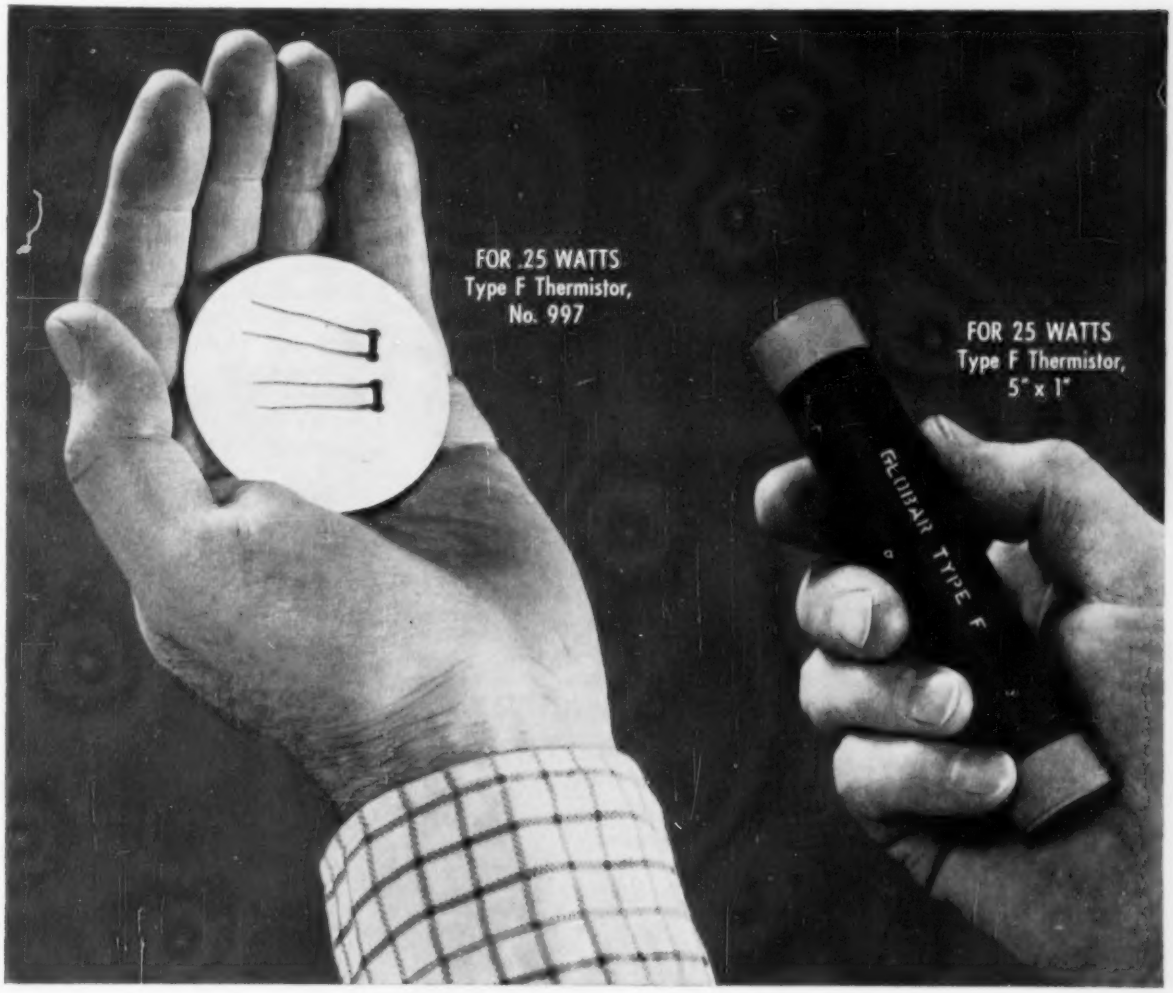
POST AMPLIFIER
for measuring noise figure

RS ELECTRONICS CORP., 435 Portage Ave., Palo Alto, Calif., announces a post amplifier for study of i-f amplifiers. It is particularly useful for making noise figure measurements in conjunction with the company's noise generator.

The unit features an input cathode follower terminating in a 3-db attenuator (utilizing 1-percent precision resistors) actuated by a spring-return switch, with provisions for simultaneously controlling the noise generator. A panel switch permits selection of two separate amplifiers. An integral vtvm, with a 4-in., 0 to 50 μa movement, serves as an amplitude comparator.

Literature

Microvolt Generator. The Hickok Electrical Mfg. Co., 10514 Dupont Ave., Cleveland 8, Ohio. A 4-page folder illustrates and describes model 295X universal, all-band



Only **GLOBAR**® *Ceramic Resistors can give you design* **FLEXIBILITY** *like this!*

THESE TWO EXTREMES in thermistors were designed by GLOBAR® engineers to meet specific circuit requirements of two of our customers. Chances are that your particular application will not require either of them... but will fall somewhere in between. But our experience in working out difficult design problems like these, plus our flexibility in production, is your assurance that a GLOBAR® Thermistor design will satisfy your requirements best.

GLOBAR® THERMISTORS are available with temperature coefficients ranging from .3% per degree C at 25° C up to 4.5% per degree C at 25° C, and in a broad range of body sizes for special electronic packaging. Both thermistor sizes shown above, while originally custom-designed, are still in production and currently available.

FREE ENGINEERING BULLETIN gives detailed information on uses and specifications of all three types of GLOBAR® Thermistors — F, B and H. Ask for Bulletin GR-3 — and, if you have a circuit problem, send us the basic details. Our engineers will assist you, without obligation. Write The Carborundum Company, Dept. E 87-68, Niagara Falls, N. Y.

GLOBAR® *Ceramic Resistors*

by **CARBORUNDUM**

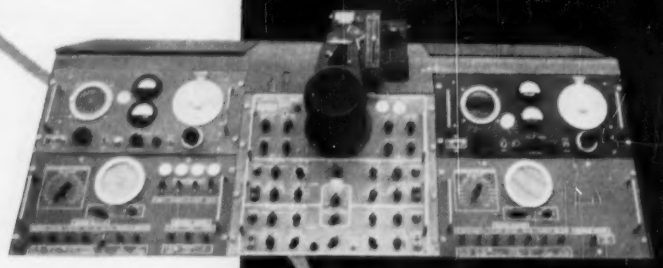
REGISTERED TRADE MARK

87-68

Want more information? Use post card on last page.

NEMS-CLARKE Special Purpose Receivers are designed for optimum performance in telemetering, guided-missile monitoring and radiosonde reception and many other applications calling for superior performance. These Receivers are now in use by most of the leading aircraft companies.

CONVAIR SPECIFIES NEMS-CLARKE ALL-PURPOSE RECEIVERS



Above photo shows portion of telemeter ground station test unit at Convair's Guided Missile Plant in Pomona, Cal., using the NEMS-CLARKE Receiver.

For further details Write Dept. 8-3

NEMS-CLARKE Incorporated

PRECISION ELECTRONIC INSTRUMENTS
SILVER SPRING, MARYLAND

Examine the tubular metal parts shown here twice size. If you use anything similar . . . in large quantities . . . important savings can be yours. Send us the part and specs. Our quotation will show why the Bead Chain Company's MULTI-SWAGE Process has long been known as the most economical method of making electronic tube contact pins, terminals, jacks and sleeves. And, why more and more users of mechanical parts (up to ¼" dia. and to 2" length) employ our facilities. WRITE for Data Bulletin.

THE BEAD CHAIN MANUFACTURING CO.,
Tr. Mark 88 MOUNTAIN GROVE ST., BRIDGEPORT 5, CONN.

microvolt and crystal-controlled generator. Information on outstanding range and accuracy, specifications and applications are included.

Unitized Chassis. Instrumentation Devices, Box 319, Buchanan, N. Y., has available a circular describing a chassis design of unitized construction without special wiring methods. Conventional wiring and components can be used to build circuits on the shelves of the chassis described. Unit chassis dimensions are illustrated.

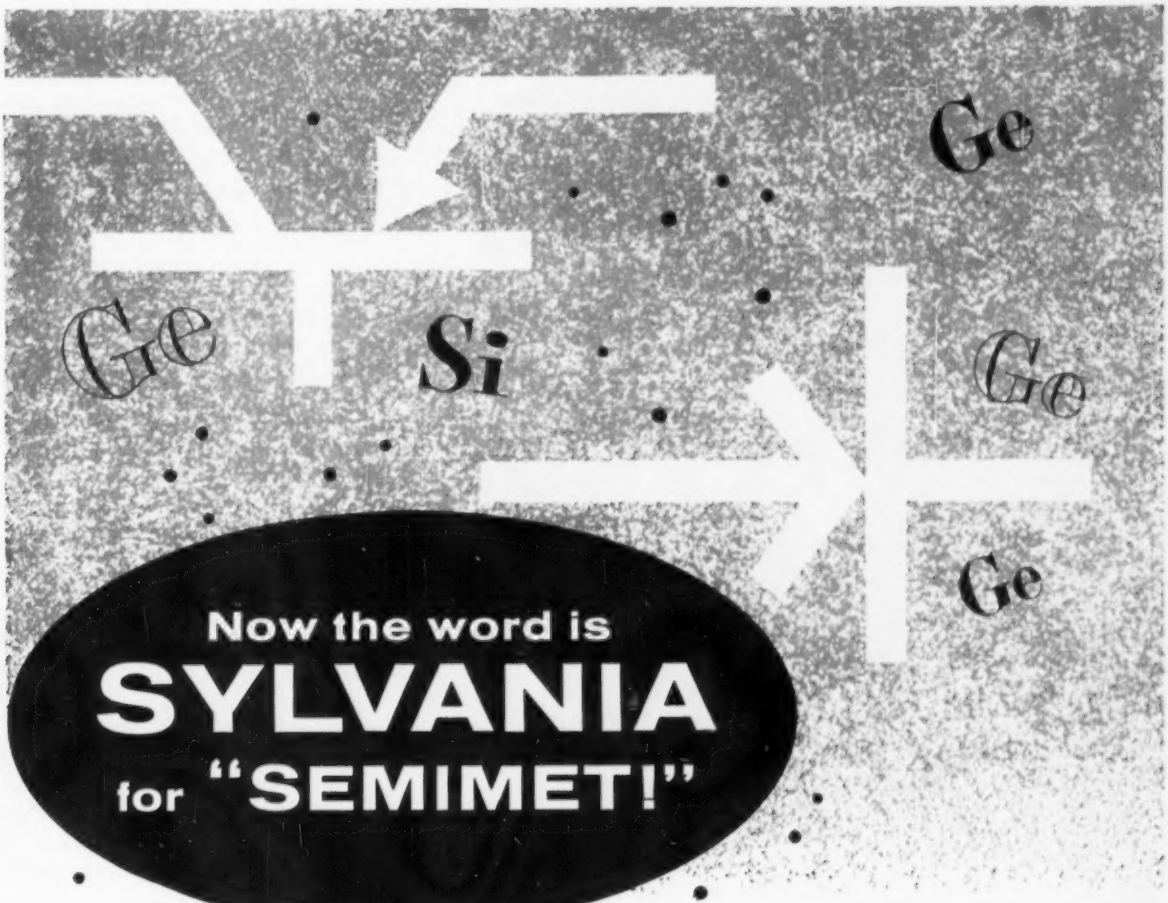
Printed Circuit Connector. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 2-color engineering data sheet on printed circuit 22-contact connector series 4 PCSC gives detailed description and specifications plus mounting and clearance dimensions. Write for technical bulletin 44C.

Variable Inductances. Superex Electronics Corp., 4-6 Radford Place, Yonkers, N. Y., has available a 4-page folder illustrating and describing a line of r-f chokes and coil forms. An industrial price schedule may also be had for the asking.

Transformer Products. United Transformer Co., 150 Varick St., New York 13, N. Y. Catalog 56 A covers a complete line of transformers, filters, and high Q coils for military, industrial, broadcast, amateur, laboratory and replacement purposes. Included are an index and net price list, illustrations and specifications.

Ultraminiature Electrolytic Capacitor. Barco, Inc., Box 1222, Milwaukee, Wisc. Catalog CS-33 is a complete listing of the 42 types of ultraminiature electrolytic capacitors. Including test charts and a cross-reference table, the brochure details these units in their range from 0.15 μf to 160μf, 1½ v dcw to 70 v dcw, and ¼ in. diameter to 23/64 in. diameter.

Resistance Standards. Consolidated Resistance Co. of America, Inc., 44 Prospect St., Yonkers, N. Y. Data sheet No. 128 describes Vari-Plug and pushbutton resistance



Ge

Si

...your single source for both transistor-grade silicon and germanium

Sylvania has long been a primary refiner of high-purity germanium. Now, newly completed facilities for the production of high purity silicon are operating on a pilot plant basis, producing the semimetal in needle or densified form, of spectrographic purity. Full production is expected in the spring. At present, transistor-grade samples are available for your testing on a letterhead request basis.

Specifications for Sylvania germanium dioxide and semimetal include ingot as-reduced (guaranteed 5 ohm cm resistivity) and polycrystalline ingot (guaranteed minimum 30 ohm cm resistivity). Whichever grade you prefer, you can be sure of continuing high quality and uniformity when you order from Sylvania.

If you use semimetals in your products . . . or plan to in the future . . . write for technical specifications and quotations on Sylvania silicon and germanium. Remember, too, that our engineering staff is always ready to help you solve semimetal application problems.

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., St. Catherine St., Montreal, P. Q.

SYLVANIA®

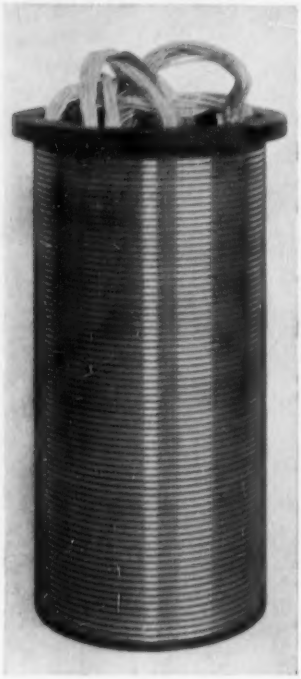
LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

Want more information? Use post card on last page.

ELECTRO TEC *Corporation*

Manufacturers

Slip Ring Assemblies of HYSOL 6000 EPOXIDE RESINS



The Electro Tec Corp. selected HYSOL 6000 Series tubes to make slip ring assemblies. That's because the outstanding electrical, thermal and mechanical properties of HYSOL 6000 epoxide compounds provided an ideal material for precise machining, intricate silverplating and ease of handling. The ability to withstand wear contributed heavily to its use in a mechanism for the transfer of electrical current from a stationary to a rotating mechanism.

Houghton Laboratories, Inc., supplies HYSOL 6000 Series tubes in certain sizes to Electro Tec Corp. and also furnishes the basic resin compound for formulating tubes in varying sizes. The 6000 Series includes a complete line of easily machined sheets, tubes and rods, room temperature and heat curing potting and casting compounds and coating and laminating varinshes.

HYSOL — PROGRESSIVE PRODUCTS THRU CHEMICAL RESEARCH — Product of HOUGHTON LABORATORIES, INC.

Again, HYSOL 6000 Series epoxide compounds show a remarkable adaptability for a variety of applications. Perhaps one of your design or production problems can be solved with the use of this new plastic. Remember, complete research, design and production facilities at Houghton Laboratories, Inc., are ready to help you in any such problem. Inquiries are invited at no obligation. Learn for yourself what HYSOL 6000 Series compounds might be able to do for you. Phone, wire or write today!

houghton laboratories, inc.
100 Houghton Ave.
OLEAN, NEW YORK

standards. Included are specifications, prices and information on optional equipment. Chief features and illustrations are shown.

Receiving Tubes. Radio Corp. of America, Harrison, N. J., has published a revised edition of the technical booklet, "RCA Receiving Tubes for A-M, F-M, and Television Broadcast." The 28-page booklet gives the characteristics of more than 600 RCA receiving tubes including picture tubes. Picture tube information is presented in a chart which lists and describes 75 types. Base and envelope connection diagrams are supplied for all tube types.

A classification chart is arranged to permit quick determination of the type designations of RCA receiving tubes according to their functions and filament or heater voltages. The company's picture tubes are listed according to their envelope size, focus method and deflection method.

The booklet carries a list price of 20 cents a copy.

Silicon Rectifiers. Sarkes Tarzian Inc., Rectifier Division, 415 North College Ave., Bloomington, Ind. An 8-page booklet covers a line of silicon rectifiers which will fill military requirements and many commercial applications. Included are information on efficiency, operating temperatures, size, construction, voltage and current ratings, series and parallel operation, typical applications, specifications and illustrations.

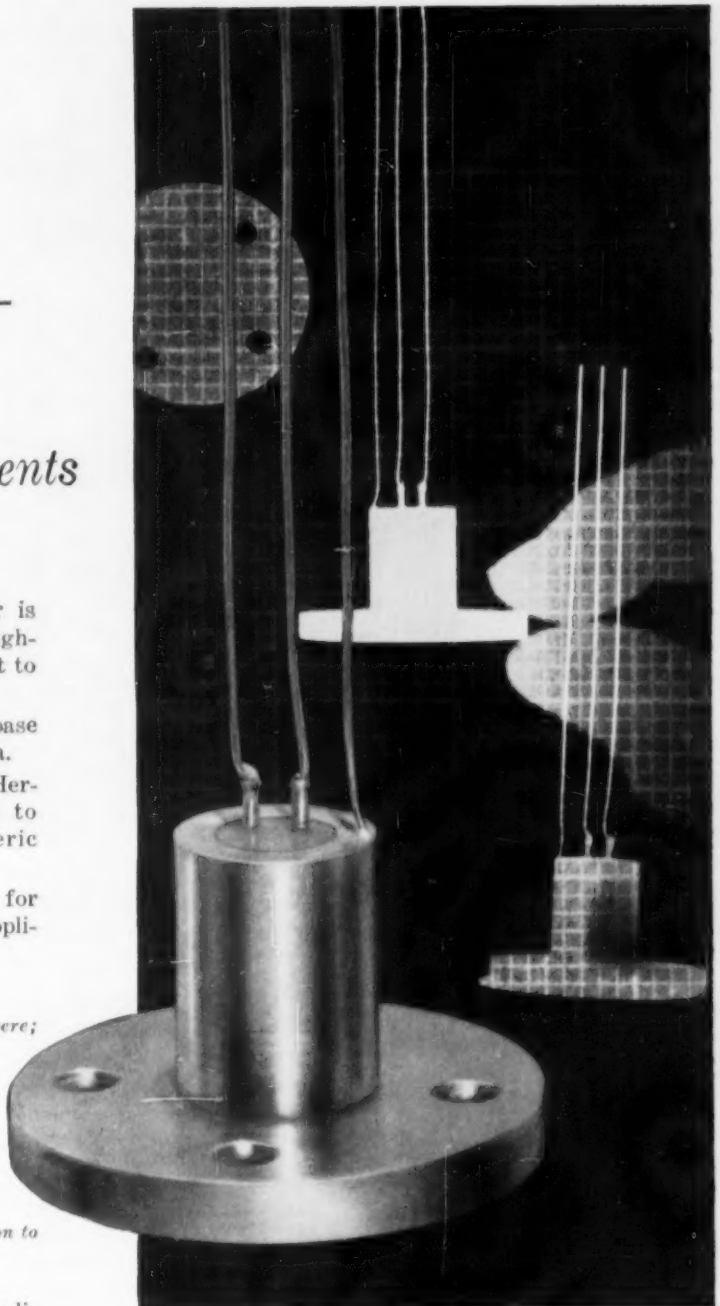
Magnetic Tape Recorders. Amplifier Corp. of America, 398 Broadway, New York 13, N. Y. The VU Magnemite series, portable, battery-operated, spring-motor magnetic tape recorders, with built-in-v-u meter is described in a 4-page folder.

The brochure completely describes in detail, features of 14 models, all of which were especially designed for field applications. A variety of single, two, three and four speed models are available and listed with their respective recording characteristics tabulated for easy reference or selection.

The various mechanical and electrical components are fully de-

WESTINGHOUSE
2-AMP GERMANIUM
POWER TRANSISTORS

High Current Gain— Maintained at Large Collector Currents



New Westinghouse XD-5081 transistor is characterized by high current gain throughout its operating range. Distortion is cut to a minimum.

THERMAL DISSIPATION. Large copper base provides an ample heat dissipating area.

LONG LIFE — RELIABLE OPERATION. Hermetically sealed in glass and metal to exclude moisture, prevent atmospheric contamination.

TYPICAL APPLICATION. Ideally suited for audio output stages and switching applications.

Performance data on the XD-5081:

Large signal current gain . . . 70 at Ic = 1 ampere; 55 at Ic = 2 amperes

Large signal frequency cutoff (common emitter) . . . > 10 kc

Maximum voltage (Vce) . . . 35 volts

Maximum current (Ic) . . . 2 amperes

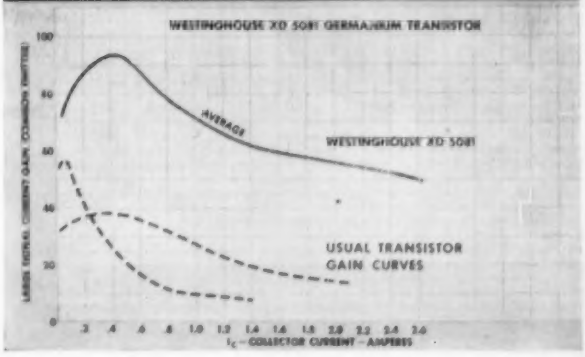
Saturation characteristic (Vce) . . . < 1 volt at Ic = 1 ampere

Thermal drop . . . 3.5°C per watt from junction to case

Maximum junction temperature . . . 100°C

Sample quantities are available immediately. Contact your nearest Westinghouse district sales office or write, Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-09002



YOU CAN BE SURE...IF IT'S

Westinghouse

The appearance of your equipment will be enhanced by PHAOSTRON meters with their high style, die cast bezels and large easy-to-read scales.

You can depend upon 2% accuracy because these meters are calibrated to within 1% of full-scale deflection with controlled, certified standards.

Continuous accuracy is assured by the UNITIZED METER MOVEMENT ASSEMBLY which provides integral mechanical stability. The aged alnico magnet of the meter is protected from the effects of stray magnetic fields by the steel case.

These units are also equipped with insulated zero adjustments.

Nine Types in 77 Standard Ranges are available at your Parts Distributor. If you have a special requirement, write to the Product Development Department for a practical recommendation.

PHAOSTRON INSTRUMENT AND ELECTRONIC COMPANY
151 PASADENA AVE., SOUTH PASADENA, CALIF.

scribed and individually illustrated. The recorders' operations are concisely explained and complete technical specifications, recommended accessories, as well as direct factory prices are included.

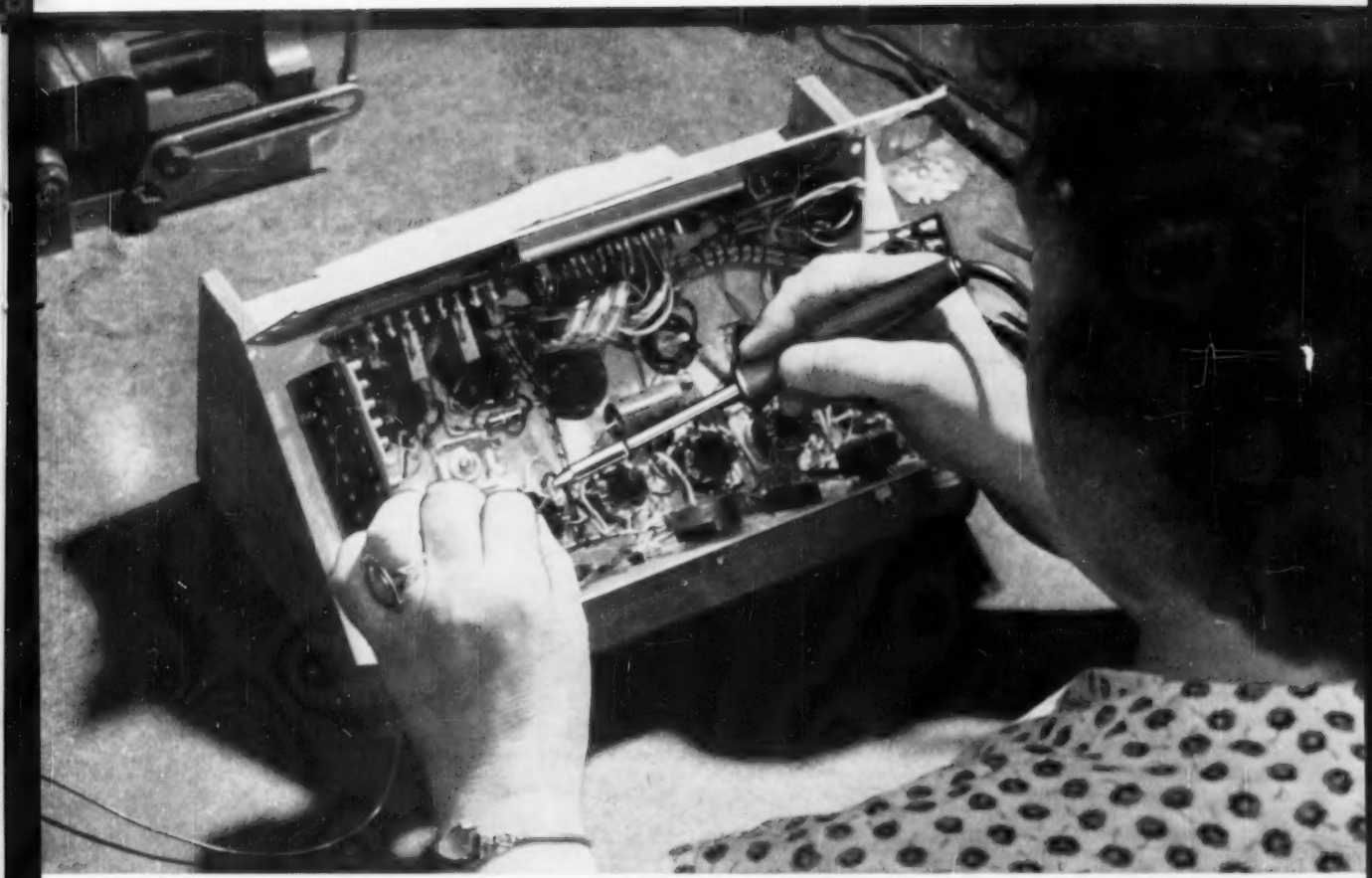
TWT Amplifiers. Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. Volume 7, No. 5 of the *Journal* covers new twt amplifiers which feature provision for simulating special microwave signals. The amplifiers described operate over the 4-8 and 7-12.4 kmc ranges with gains of 25 db or more and with maximum power outputs greater than 10 and 5 mw, respectively, at 50-ohm input and output levels. Illustrations and specifications for models 492A and 494A are included.

Tubeless D-C Power Supply. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif., has available a new bulletin describing the model 28-10 WX, 28-v ± 10 percent at 10 amperes magnetic amplifier tubeless regulated d-c power supply. The unit illustrated and described in the bulletin features regulation of 0.5 percent and ripple of 1-percent rms. All characteristics and specifications on this unit are shown.

Cavity Wavemeters. DeMornay-Bonardi, 780 S. Arroyo Pkway, Pasadena, Calif. A 4-page folder covers type DB-715 precision, broad-band cavity wavemeters. Features, applications, description, specifications and ordering information are included.

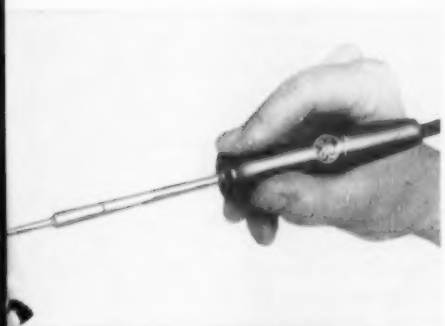
Analog Computer. Weber Aircraft Corp., 2820 Ontario St., Burbank, Calif. A 6-page folder fully illustrates and describes a low-cost general purpose analog computer which is complete within one basic unit. Applications and specifications are listed.

Connectors and Cable. Gulton Mfg. Corp., 212 Durham Ave., Metuchen, N. J., has announced a 6-page folder describing the new subminiature C-21 connectors and cable. It gives complete information concerning features, construction and applications of these Glennite C-21 subminiature connectors which oc-



HARD-TO-REACH JOINTS in Sanborn Co.'s electro-cardiographs are soldered quickly with the fine-point G-E Midget iron—with no damage to adjacent parts. Weight of iron—less than 2 ounces—helped increase output by reducing operator fatigue. The Midget's ironclad-copper tip saves Sanborn ½ hour cleaning and tinning time daily, per operator station.

Sanborn speeds assembly 13% with G-E Midget iron, a small soldering iron with big-iron efficiency



HANDLES LIKE A PENCIL—Weighing less than a package of cigarettes, the General Electric Midget soldering iron speeds production by reducing operator fatigue.

RAPID HEAT TRANSFER is achieved by locating the heater directly in the ironclad-copper tip. Result—the G-E Midget iron's heat efficiency is 90%.

THREE-IN-ONE IRON with 1/8", 1/4", 3/8" tip sizes gives you greater versatility to meet your soldering requirements. Tips can be changed in only 5 seconds.

For more information write for GED-2263, G-E Midget Soldering Iron, Section 724-2, General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

Brand New!

SWITCHCRAFT INC.
"TELEVER SWITCH"
SERIES 16000

Featuring Single-Hole Mounting

All the engineering features and outstanding workmanship of the 6000 Series "Telever Switch" are retained in this new switch.

Single hole mounting provided by 15/32" threaded bushing 3/8" long; slotted bushing and a special washer provide a convenient non-turn device.

2-position and 3-position types; locking and non-locking. A unique feature is that conversion from a non-locking action to a locking action can be made by removing a simple stamping supported by 2 screws.

Contact are welded cross bar palladium—standard. Fine silver (in various sizes) on special order.

Write for details and price

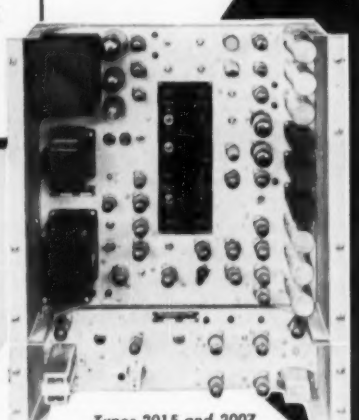
1336 N. Halsted St., Chicago 22, Ill.
Canadian Representative:
Atlas Radio Corp. Ltd., 50 Wingold Ave., Toronto, Canada

SWITCHCRAFT INC.

COLOR SIGNAL CHECKING have you SPINNING?

use TIC's NEW
Type 2015
DIFFERENTIAL GAIN & PHASE MEASURING GENERATOR
and Type 2036
DIFFERENTIAL GAIN & PHASE ANALYZER

Now you can conveniently measure small values of differential gain and phase with no more than a 5cm scope deflection! Differential gain can be read at 2%/cm. Differential phase at better than 0.5%/cm. The test signal contains the measurement signal, sync, color burst and front and rear porches. The measurement signal is a saw or 10-step, with 5% to 20% superimposed RF. Color certification tests are made to ±1% with the continuously variable, calibrated phase shifter. Type 2007 Sync Signal Simulator is available as attachment.



Types 2015 and 2007 illustrated

Write for COMPLETE INFORMATION

TIC **Tel-Instrument** ELECTRONICS CORP.
728 GARDEN STREET, CARLSTADT, NEW JERSEY

cupy only one-quarter the volume of standard AN connectors and can withstand up to 100 g shock. Handy scale and actual size cutaway diagrams, easy-to-use ordering data, and specific technical information are all prominent features in the folder.

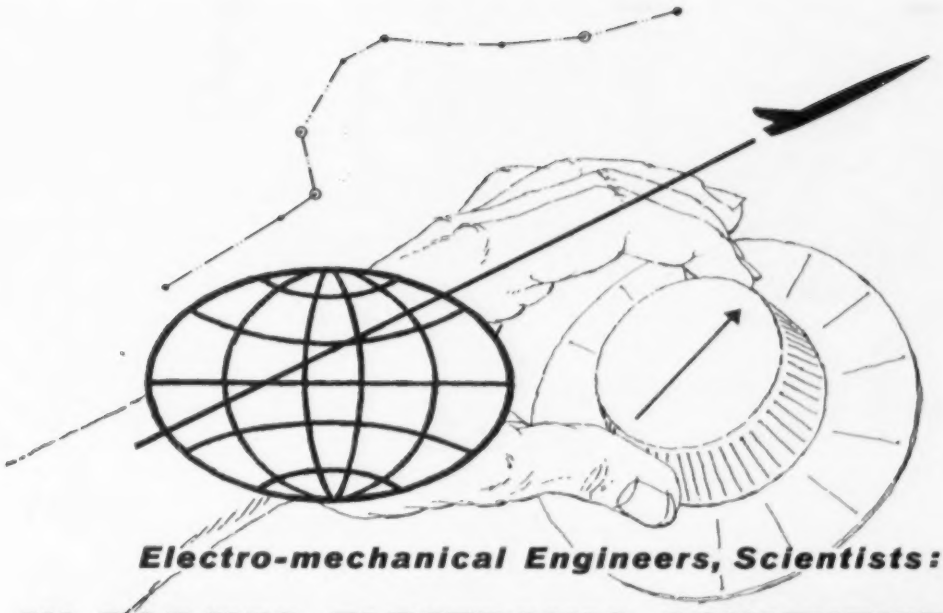
Silicon Junction Rectifiers. National Semiconductor Products, 930 Pitner Ave., Evanston, Ill. Bulletin TIB 22-55 covers high power silicon junction rectifier types NS-P1 and NS-P1R (reversed polarity version of NS-P1). Tentative ratings, mechanical and electrical data and physical characteristics are included.

High-Power Dummy Load. A. R. F. Products, Inc., 7627 Lake St., River Forest, Ill., has available a bulletin on its model ADA-1 high-power dummy load which is used to replace the antenna in a radio transmitter when it is desired to keep the equipment operating for testing or alignment purposes. Application information, description, illustration and typical test results are included.

Static Control Systems. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa. The new Cypak static control systems are discussed in a new booklet entitled "The Whys and Wherefores of Cypak." Illustrated with photographs, drawings and circuit diagrams of actual equipment, booklet B-6584 covers the systems from four points of view: the need for static industrial controls, what they are, how they operate and where they can be used.

Time Delay Relays. A. W. Haydon Co., Waterbury, Conn., has available a new bulletin describing operation and specifications of the 6400 series d-c, 11400 a-c, and 24300 series 400-cycle time delay relays with proportional delayed reset for delaying application of plate voltage in gas and vacuum power tubes until filaments or heaters have reached the proper temperature.

Bulletin TD402 describes standard delayed reset units, reclosure time, tolerance, operation and special application of proportional de-



Electro-mechanical Engineers, Scientists:

IN TODAY'S ELECTRONIC ACHIEVEMENTS LIE TOMORROW'S CAREERS

Your work in advanced guidance and control systems and components at AUTONETICS today is excellent assurance of *long-range* opportunity. Problems like heat resistance, weight reduction and sub-miniaturization in electro-mechanical devices for missiles and manned aircraft have a direct application to non-military industry.

The work at AUTONETICS is challenging and professionally rewarding. Nearly 100 projects are now underway—most of which have not yet been printed in journals or texts. This diversity means good opportunity to find the field that is best for your particular talent, training and desires.

In developing and designing precision electro-mechanical equipment, you will use the finest digital and analog computers and other advanced research and test facilities at AUTONETICS.

In addition to all the physical advantages at AUTONETICS, you will welcome the professional attitude of your colleagues here. You can expect to be informed about your personal progress, have your ideas listened to.

If you are interested, AUTONETICS welcomes your inquiry. All replies will be held in the strictest confidence.

Choice openings for:

Computer Specialists Electro-Mechanical Designers Environmental Test Engineers Electronic Component Evaluators Instrumentation Engineers Fire Control Systems Engineers Flight Control Systems Engineers Electronics Research Specialists Computer Programmers Computer Application Engineers Automatic Controls Engineers Electronic Engineering Writers Inertial Instrument Development Engineers Preliminary Analysis and Design Engineers

Contact: **Mr. D. S. Grant, Engineering Personnel Office**
Autonetics, Dept. 991 - 20EL, 12214 Lakewood Blvd., Downey, Calif.

Autonetics
A DIVISION OF NORTH AMERICAN AVIATION, INC.

AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE

Want more information? Use post card on last page.

NEW!

AND ONLY

$249.50

THE MODEL T-1/E LABORATORY-PRECISION

Q-METER

■ The new ADVANCE LABORATORY Q-METER, Model T-1/E, is the first instrument of its kind incorporating an overload-proof VTVM indicator, *and at a price below what you would expect to pay.* This instrument provides a convenient method for making RF measurements of Q, Inductance, Capacitance and Power Factor at frequencies between 100 Kc and 100 Mc — in six frequency ranges, accurate to ±1%. Calculation of Inductance and Impedance is simplified by the use of a variable capacitor, calibrated in three scales: (1) in mmfd from 40 to 550, accurate to 2%, (2) in Zf from 4,000 to 300 (ohms, Mc) and (3) in Lf from 600 to 50 (microhenrys, Mc.) There is a vernier capacitor of ±2.5 mmfd. Q is read directly in two scales: 10-100 and 40-400, accurate to ±5%. Rugged aluminum front panel; polished, grey enamel finish. Rhodium-plated terminals throughout. Power supply for 110-125V, 40-60 Cy., AC.

SIZE: 15½" wide, 10½" high, 6½" deep. WEIGHT: 14 pounds.

WRITE TODAY FOR COMPLETE SPECIFICATIONS

Sole U.S. Agents: **FISHER RADIO SALES CO., Inc., 21-39 44th Dr., L. I. City 1, N. Y.**

the only complete source for

WAVE GUIDE *castings in*

BRONZE
ALUMINUM
MAGNESIUM
and ferrous alloys

ONLY AT ALLOY PRECISION can you obtain all 3 precision casting processes from a single source!

ONLY AT ALLOY PRECISION is the process selected to match your part. Your design is not limited by the requirements of a single process.

ONLY AT ALLOY PRECISION can you be sure of a completely unbiased production evaluation of your existing or projected precision castings.

RUSH US YOUR BLUE PRINTS TODAY!

ALLOY PRECISION castings company

Dept. 46 • East 45th and Hamilton
Cleveland 14, Ohio

• Frozen Mercury
• Lost Wax
• Shell Molding

layed reset time delay relays, available for civilian and military requirements.

Ceramic Transducers. Gulton Mfg. Corp., Metuchen, N. J., has available a comprehensive 12-page brochure covering the use of piezoelectric ceramic transducers. The 2-color booklet outlines the many applications of ceramic transducers including ultrasonic shock and vibration, medical and underwater sound equipment, in addition to presenting complete physical and electrical properties and specifications for the ceramic materials. Other features covered include a discussion of resonant frequency characteristics and detailed tables outlining standard sizes and shapes of transducers available.

Miniature Feed-Through Capacitors. The Gudeman Co., 340 W. Huron St., Chicago 10, Ill. A 4-page engineering bulletin (No. 271-2) illustrates and gives complete technical data on miniature paper dielectric hermetically sealed feed-through capacitors designed for use in r-f interference suppression. Included are capacitance listings, dimensions and voltages, dimensional drawings and engineering specifications on test voltage, life test, insulation resistance, power factor and military environmental requirements.

Miniature Connector. DeJUR-AMSCO Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 2-color, 2-page technical bulletin gives description, specifications, enlarged views, mounting and clearance dimensions of the new series 20 miniature Continental connector with coaxial contacts. Write for bulletin 16C.

F-M-Carrier Recording Equipment. A-V Mfg. Corp., 730 Fifth Ave., New York 19, N. Y., has issued a new bulletin illustrating and describing its type 6 f-m-carrier recording system. Recording data from d-c to 10,000 cps, the basic system described consists of five building blocks. Fourteen tracks can be included in one system and A-V building block units can be

MEMO

TO Engineering Dept.

SUBJECT

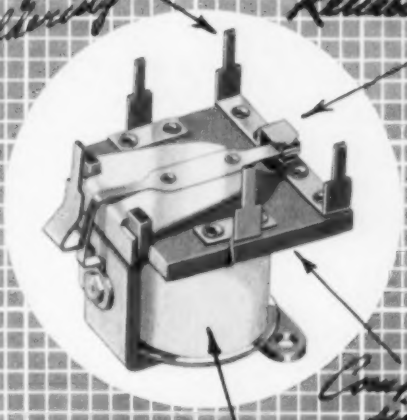
MINIATURE SENSITIVE RELAY (TYPE MS)

(IDEAL FOR PRINTED CIRCUITS)

Note desired RBM features will cut Our Assembly Costs

Self locking Terminals position Relay before Soldering

X-Bar Contacts insure ultimate in Circuit Switching Reliability



Compact size

Coil Construction meets unusual climatic conditions

Construction—Printed circuit terminals are designed with snap-in feature which holds relay in printed circuit board without lugging prior to solder dip.

Other versions of MS relay available with standard solder type terminals and insulating base, where required. Also with 4 N.O. isolated circuits having common make.

While not yet in production, extra-sensitive version has been developed. Maximum coil resistance 18,000 ohms, nominal sensitivity .030 watt, maximum sensitivity .020 watt, overall height 1-9/16". All other details same as standard MS relay.

Application—Type MS is an ideal relay for any application requiring a compact, highly reliable single pole D. C. device, where a low cost solution is required because of volume usage and competitive problems.

The fact that industry has already used over a million units of this design is your assurance that the R-B-M Type MS relay will meet your most exacting requirements.

Contacts used in Type MS are of the cross bar type, which offer the ultimate in reliability throughout the life of the relay. Molded bobbin design has eliminated coil failure on sensitive applications under severe climatic conditions.

OTHER VERSIONS

SOLDER TERMINALS
4 isolated circuits with common make contact.

INSULATED BASE
Solder terminals mounted on insulating base.

EXTRA SENSITIVE VERSION

ENGINEERING DATA	
Specifications	Miniature Sensitive Relay Type MS
Contact Form	S. P. D. T.
Contact Rating	1 amp. 32 V.D.C. non-inductive
Coil Resistance	Up to 10,000 ohms
Nominal Sensitivity (Coil Input)	.060 Watt
Maximum Sensitivity	.040 Watt
Approx. Dimensions	1⅛ x 1⅛ x 1½"

CORD SETS
WIRE HARNESSES
MAGNET WIRE
OTHER PRODUCTS

Send for Descriptive Bulletin MS-1

RBM DIVISION

ESSEX WIRE CORPORATION, *Logansport, Indiana*

Shasta INSTRUMENTS

designed for the user!

MODEL 1201A
WWV RECEIVER

Features:

- ★ Coverage of all WWV and WWVH frequencies; 2.5, 5, 10, 15, 20 and 25 mc
- ★ Individual crystal for each frequency
- ★ High sensitivity and selectivity
- ★ Compact, reliable construction

Description:

This high-quality instrument is designed to provide laboratories and industries with a reliable, accurate means of utilizing primary standard times and frequencies supplied through the National Bureau of Standards' radio stations WWV and WWVH. Every feature for convenient operation and dependable performance is included.

Brief Specifications:

Frequency Coverage: 2.5, 5, 10, 15, 20 and 25 mc
Sensitivity: Better than 1 microvolt for 3 db signal plus noise-to-noise
Selectivity: 1 kc at 3 db down
Dimensions: 19"W x 5¼"H x 9-5/16"D; relay rack mounting

Weight: 17 lbs.
Price: $495 f.o.b. factory

Write today for Technical Bulletin 1201-A; please address Dept. SG-4

OTHER SHASTA QUALITY INSTRUMENTS

Expanded Scale Frequency Meters and Voltmeters • Audio Oscillators • AC Voltmeters • Power Supplies • Wide Band Amplifiers • Bridges • WWV Receivers • Decade Inductors.

Shasta *division*

BECKMAN INSTRUMENTS INC.
P.O. Box 296, Station A, Richmond, California
Telephone LAndscape 6-7730

5-13

Stainless Fastenings
IN STOCK

ANTI-CORROSIVE METAL PRODUCTS

FAST SERVICE ON SPECIALS

WRITE FOR FREE CATALOG

Immediate delivery from the world's largest stock

Anti-Corrosive Metal Products Co., Inc.
CASTLETON-ON-HUDSON, N. Y.

plugged together to provide both direct and f-m type recording. Ask for bulletin 107.

Components and Accessories. Herman H. Smith Inc., 2326 Nostrand Ave., Brooklyn 10, N. Y. A new 32-page catalog features an expanded line of plugs and jacks, all with schematic diagrams and detailed technical specifications. Printed in 2 colors throughout, catalog No. 56 is an important reference work for everyone connected with the design and production of electronic equipment.

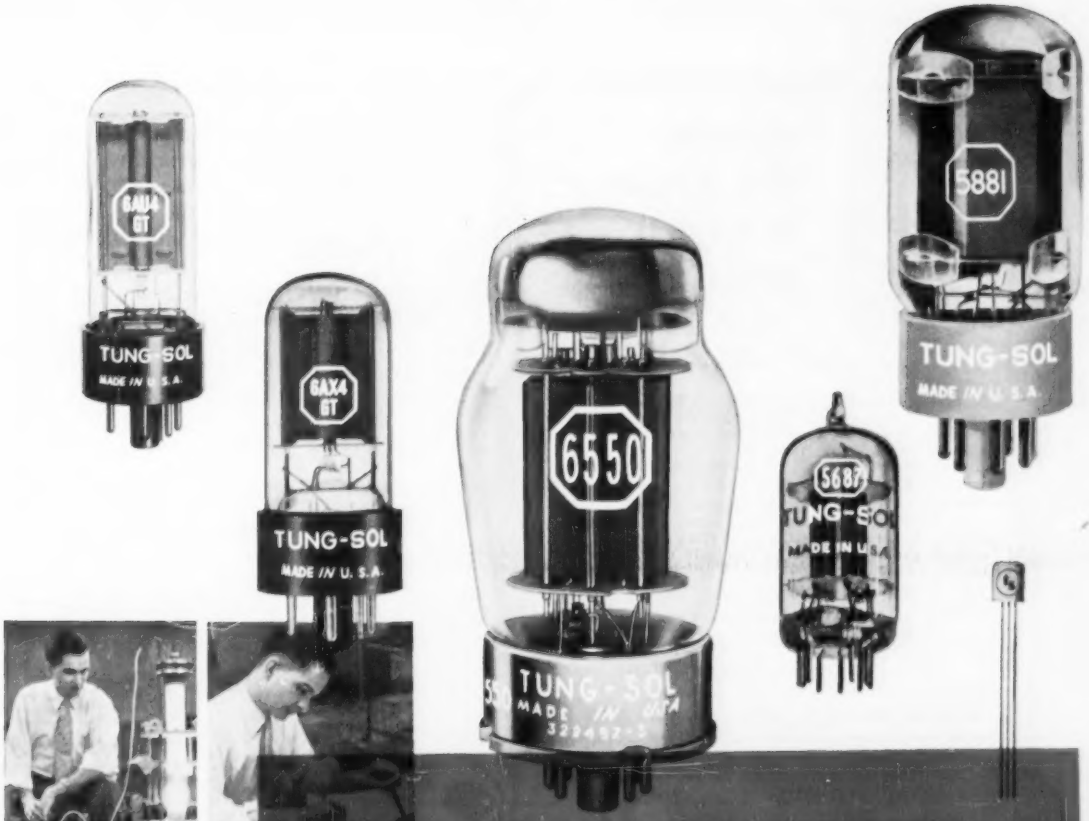
Antenna Catalog. Andrew Corp., 363 E. 75th St., Chicago 19, Ill., has produced a comprehensive catalog on antennas, antenna systems and transmission line. The 100-page catalog contains the product description and engineering data of over 500 products. Twenty pages are devoted to system engineering data and related information that engineers specializing in this field of electronics will find informative.

Ceramic Capacitors. Cornell-Dubilier Electric Corp., South Plainfield, N. J. A comprehensive 20-page catalog (616) covers all standard or popular ceramic capacitors— disk, tubular, slug-types and special types—manufactured by the company.

The illustrated, 3-color catalog consolidates an extensive variety of ceramic capacitors available to meet any precise applications. These include single and dual capacitance disks, tubulars, printed circuitry and automation disks, h-v slug types and special design types. The Tiny Mike line is also described.

Resin Booklet. Ohio-Apex Division, Food Machinery & Chemical Corp., Nitro, West Virginia. A 6-page booklet describes Dapon, a new material developed to fill a need for a solid prepolymer of diallyl phthalate. Included are information on applications, resin blends, laminates, and technical data on properties and solution properties.

Terminal Blocks. Marathon Electric, Wausau, Wisc. The complete line of Controlead heavy-duty terminal blocks is illustrated and



RESEARCH, DESIGN, DEVELOPMENT AND QUALITY PRODUCTION IN VOLUME

TUNG-SOL®

TUNG-SOL ELECTRIC INC., Newark 4, N. J.

SALES OFFICES: ATLANTA, COLUMBUS, CULVER CITY, DALLAS, DENVER, DETROIT, MELROSE PARK (ILL.), NEWARK, SEATTLE

Miniature Lamps | Sealed Beam Headlamps | Signal Flashers | Radio And TV Tubes | Aluminized Picture Tubes | Special Purpose Tubes | Semiconductors

Want more information? Use post card on last page.

FREE DESIGN DATA BOOKLET

HOW TO APPLY THERMAL RELAYS

Based on 10 years experience in the design, manufacture and engineering application of thermal relays, this booklet contains diagrams and recommendations to save you hours of engineering time. Here is data on thermal relays with specifics on their use in high-power electron tube circuits, automatic controls and other applications.

The booklet discusses design factors that influence the time delay, instantaneous and saturation values, re-operate and recovery periods . . . gives information on contact protection, how to eliminate contact chatter, temperature compensation and vibration problems.

For your free copy of "How to Apply Thermal Relays"* write:

*Reprinted from "Electrical Manufacturing"

Thomas A. Edison

A GREAT NAME CONTINUES GREAT NEW ACHIEVEMENTS

Thomas A. Edison

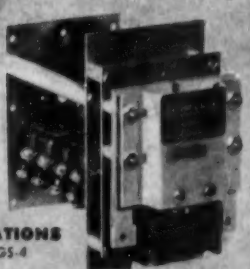
INCORPORATED

INSTRUMENT DIVISION • 54 LAKESIDE AVENUE • WEST ORANGE, NEW JERSEY

HIGH ALTITUDE BALLOON CONTROL INSTRUMENTS

require **MAXIMUM Performance**

MINIMUM Size - Weight - Power Drain



BRAILSFORD AGS TIMERS ARE UNMATCHED IN THESE BASIC REQUIREMENTS

IF YOU HAVE A TIMING PROBLEM WHERE SIZE, MASS AND POWER DRAIN ARE CRITICAL READ THESE

SPECIFICATIONS

Model AGS-4

NUMBER OF CIRCUITS—4 SPDT • SIZE—3 IN. X 2¼ IN. X 1¾ IN.

WEIGHT—6.1 OZ. • POWER INPUT—.008 AMP. @ 6 V.D.C.

SPEED REGULATION ±1.0% @ ±50.0% VOLTAGE SHIFT

ALSO AVAILABLE 1—2 OR 3 CIRCUITS

WRITE FOR LITERATURE

BRAILSFORD & CO. INC.

670 MILTON ROAD • RYE, N.Y.

ENGINEERING DEVELOPMENT MANUFACTURING

SUB FRACTIONAL WATT D.C. MOTORS — BRAILSFORD — SIGNALLING SYSTEM COMPONENTS

described in a 4-page folder. Included are specifications on the series 1000 solderless connector block, series 2000 direct wiring block, series 3000 stud terminal block, series 6000 screw terminal block, series 6000-SC short circuiting block, and series 6000-H hinged cover block.

Ultraviolet Microscope. Norden-Ketay Corp., Snow & Union Sts., Boston, Mass. A 4-page illustrated bulletin deals with the automatic color translating ultraviolet microscope which is available for accurate structure determination and indication of absorption spectrum. Bulletin 370 describes applications and operating principles. A bibliography of experimental results obtained with the microscope is given. Prices are included.

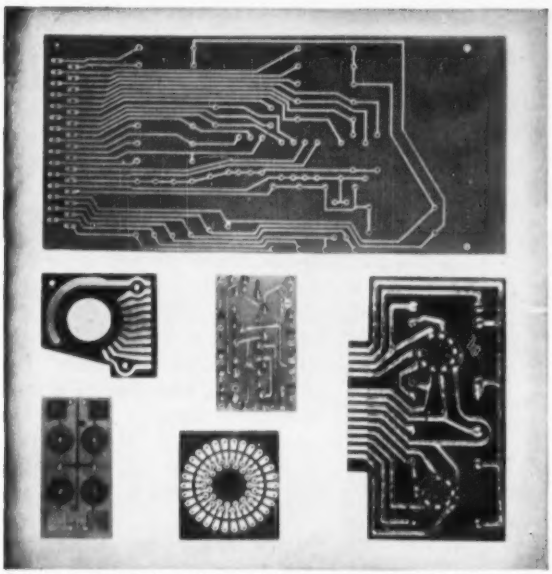
Alternators. Leece-Neville Co., 1374 E. 51st St., Cleveland 3, Ohio, has released 2 new 4-page folders illustrating and describing two new models of its standard line of alternators, models 5368-G3 and 5370-G6. Designed to replace d-c generators on passenger cars, light and medium trucks, school busses and the like, the models described are also particularly suited for such specific types of vehicles with two-way radio or telephone as police cars, highway patrol, taxicabs and utility trucks. A transformer may be attached to the alternator discussed to give up 800 w of 110-v portable power.

The folders are illustrated with photos, charts and engineering drawings. Specifications, application and installation information are likewise featured.

Soft Soldering by Induction Heating. McDowell Electronics Inc., 117 Woodside Ave., Metuchen, N. J. Bulletin 561 is a 4-page folder that tells how soft soldering by induction heating can increase production output, cut labor costs, decrease production rejects, eliminate cold solder joints and assure uniform penetration. Illustrations and design notes are included.

Variable Delay Line. Helipot Corp., 916 Meridian Ave., South Pasadena, Calif. Data sheet No. 54-74 covers

For the most dependable printed circuits, you need the high bond strength, workability, heat-resistance of C-D-F DILECTO® METAL-CLAD LAMINATES



Printed circuits based on C-D-F materials are being used with great success in military electronic equipment, commercial television and radio sets, telephone switchboards—even sub-miniature radiosonde equipment and hearing aids.

Photos courtesy of Photocircuits, Inc., Glen Cove, N. Y.

HIGH BOND STRENGTH—C-D-F's special adhesive for metal-clad Dilecto bonds the copper foil to the plastic without affecting the laminate's superior electrical properties. Heat-resistance, dissipation factor, dielectric constant, dielectric strength, and insulation resistance of the Dilecto base remain unaffected. The closely-bonded foil can be etched cleanly and dipped in hot solder to 220°C. (428°F.) for ten seconds with a guarantee of no blistering or separating. Metal-Clad Dilecto can be punched or machined either before or after etching.

EXCELLENT WORKABILITY—On all five Dilecto metal-clad grades, you can solder, punch, saw, and assemble components either by hand or automatically. Thanks to the inherently superior workability of the plastics laminate over that of ceramic-type materials, Dilecto can be dropped, jammed into tight chassis, and otherwise treated roughly on the assembly line and in service.

HIGH HEAT-RESISTANCE—Metal-Clad Dilecto Laminates are made of phenolic, epoxy, or Teflon* resin for various conditions of service and assembly, and have either cellulosic paper or woven glass-fabric base. All are ideally suited to printed-circuit applications in which heat-dissipation is a major problem. Continuous exposure to high ambient operating temperatures in enclosed electronic equipment has no significant effects on Dilecto's electrical and physical properties.

UNLOAD YOUR HEADACHE HERE! C-D-F, a big, reliable source of supply, can help you get the most for your printed-circuit money by reducing rejects, lowering fabrication costs, assuring dependable quality every time. Send us your print or problem, and we'll gladly supply appropriate test samples free. See our catalog in the Product Design File (Sweet's) or send for the new 20-page Dilecto catalog. Let your nearby C-D-F sales engineer (listed in Sweet's) help you right from the design stage!

TYPICAL PROPERTY VALUES

	Copper-Clad PHENOLIC (Grade XXXP-26)	Copper-Clad PHENOLIC (Grade XXXP-24)	Copper-Clad EPOXY (Grade GB-116E)	Copper-Clad EPOXY (Grade GB-181E)	Copper-Clad TEFLON* (Grade GB-116T)
BOND STRENGTH—0.0014" foil (Lbs. reqd. to separate 1" width of foil from laminate)	5 to 8	5 to 8	8 to 12	8 to 12	5 to 8
MAXIMUM CONTINUOUS OPERATING TEMP. (Deg. C.)	120	120	150	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil.)	800	800	700	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90¾ RH	50,000	50,000	30,000	20,000	Over 10^6 megohms
DIELECTRIC CONSTANT 10^6 Cycles	4.20	4.20	4.90	4.95	2.85
DISSIPATION FACTOR 10^6 Cycles	0.026	0.026	0.019	0.018	0.0006
ARC-RESISTANCE (Seconds)	10	10	60	80	180
TENSILE STRENGTH (psi.)	16,000 x 13,000	14,000 x 11,000	46,000 x 42,000	48,000 x 44,000	23,000 x 21,000
FLEXURAL STRENGTH (psi.)	21,000 x 18,000	19,000 x 16,000	60,000 x 55,000	75,000 x 65,000	13,000 x 11,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.40 x 0.35	0.40 x 0.35	6.5 x 6.0	13.5 x 11.5	6.0 x 5.0
COMPRESSIVE STRENGTH flatwise (psi.)	28,000	27,000	60,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Cotton rag paper	Cotton rag paper	Fine-weave, medium-weight glass cloth	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural greenish	Natural Brown	Natural	Natural	Natural

All these standard grades are available with 0.0014", 0.0028", 0.0042", or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

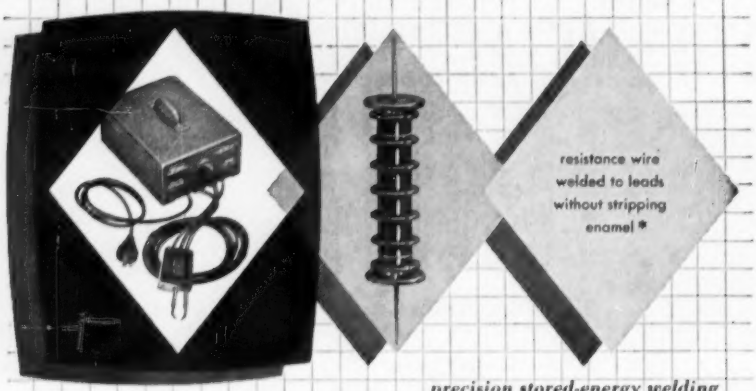
*duPont Trademark

CONTINENTAL DIAMOND FIBRE

CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.

NEWARK 16, DELAWARE

TERMINATE PRECISION RESISTORS
WITH SPEED AND RELIABILITY



precision stored-energy welding

WELDMATIC MODEL 1012 TWEEZER TYPE WELDER
welds fine wire to leads or tabs while resistor is on winder.
Enamel stripping and flux contamination eliminated,
with production time halved. Welded connection
is very positive, stable, and rugged.

*Made by Ircal Industries
(subsidiary, IRC)

Unitek WELDMATIC

UNITEK CORPORATION
259 Halstead Avenue • Pasadena 8, California
*Write for Complete Technical Information
on Stored Energy Welding*

A COMPLETE SPINNING SERVICE
FOR THE
ELECTRONIC INDUSTRY

Metal Spinning

FROM 10′ PARABOLA TO THIMBLE-SIZE CASE

Metal Fabrication

COMBINES SPINNING WITH FABRICATION,
WELDING and ANNEALING TO PRODUCE A
FINISHED PART. (Gov't. certified welders)

Mu Metal Shields

ANNEALED IN OUR OWN HYDROGEN ATMOSPHERE OVEN

COMMITMENTS SOLICITED. SEND FOR OUR BROCHURE
WE ARE A JOB SHOP — WE HAVE NO PRODUCT OF OUR OWN

TEINER engineering corporation
115-E Madison Street, Malden 48, Mass.

the 1-μsec Helidel variable delay line that has a longer total delay than in the 0.2-μsec and 0.3-μsec units. Delay in the unit described is adjustable in increments of 0.04 millimicroseconds; rise time, 0.08 μsec maximum; frequency response, from 0 to 4.5 mc. Overshoot and phase distortion are negligible.

The 1-μsec Helidel described is a 10-turn unit with mechanical rotation of 3,600 deg +5 deg −0 deg. Other applications include use in laboratory electronic measuring devices in color telecasting and high-speed computers. It is useful for measurement of potentiometer phase shift at 400 cycles; 360-deg phase shift at 1 megohm, and 1,800 deg at 5 megohms.

The unit described is also valuable as a memory circuit in the development of high-speed computers because of the relatively long, distortion-free delay.

Gear Boxes. Southwestern Industries Inc., 5880 Centinela Ave., Los Angeles 45, Calif., has issued an illustrated catalog sheet describing in detail a series of flexible, precision-made gear boxes for use in actuators, computers and small electronic components. Designated series 145 and 167, the gear boxes described provide maximum torques from 150 oz in. to 200 oz in. with high efficiency and low backlash.

Units discussed are designed for mounting directly to small electric motors, and can be supplied with an input shaft if desired. Ball bearings are used throughout to provide maximum operating efficiency. Complete specification tables are included in the catalog sheet.

D-C Power Supplies. Universal Electronics Co., 1720 Twenty-Second St., Santa Monica, Calif., has released an 8-page catalog (BF56), describing an expanded line of regulated d-c power supplies. The catalog includes approximately 125 models under the headings: Standard, Precision, Ultra-Precision, For Transistor Research, Unireg (Mag-Amp), Fixed Voltage, Constant Current and Custom Designs.

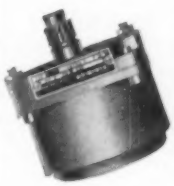
—the modern successor to the galvanometer

Research and production tests speeded with the ElectroniK **Null Indicator**

Design your servo circuits around these Brown components

Brown
Converters

Long-lived, low-noise, thoroughly shielded "choppers" for d-c to a-c conversion in radar, computers, servo and balancing circuits. SPDT switching action. Applicable to voltages as small as 1 x 10^{-4}. For 25, 40, 60 and 400 cycles. Prices from $35.75. For full characteristics, write for Data Sheets No. 10.20-1 and 10.20-5.



Brown
Servo motors

2-phase reversible motors ideal for servomechanisms, remote positioning, null circuit balancing, computers. High torque . . . fully enclosed, self-lubricating. No-load speeds of 27, 54, 167, 333 and 1650 rpm available. Operate from 115-volts, 60-cycles. Numerous variations in pinion, shaft, leadwires and materials are available for special requirements. Prices from $40.50. Write for Data Sheet 10.20-2c.

JUST about anything a galvanometer can do . . . in laboratory or production line testing . . . the *ElectroniK* Null Indicator can do better, easier and faster. A completely electronic null detector, it can be used with any d-c bridge or potentiometer circuit. It is unaffected by vibration . . . needs no leveling or special mounting. It has plenty of sensitivity for the most accurate measurements. It's fast . . . indicates in less than ½ second. It takes heavy overloads without damage . . . eliminates delays from "loss of spot" that hamper use of spotlight galvanometers. Just plug into any 115-volt, 60-cycle line, and it's ready to use. Look at these characteristics—*then order one now for your own test work!*

Period—less than ½ second
Current sensitivity—.001 microamp/mm
Voltage sensitivity—1 microvolt/mm
Input impedance—1000 ohms at max. sensitivity
Overload rating—1 volt at max. sensitivity
Stability—less than 1 mm zero shift/hour
Damping—critically damped. Independent of external resistance.
Terminals—input and ground, for spade, pin, or banana plugs

PRICE—only $175.00 net, f.o.b. Philadelphia

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4591 Wayne Avenue, Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

Prices and specifications subject to change without notice

Plants and People

Edited by WILLIAM G. ARNOLD

Electronics manufacturers continue to build new plants and expand existing facilities through acquisitions. Engineers are promoted to new positions, join new companies. Industry associations elect new officers, plan 1956 activities

Missile Firms Plan Extensive Expansions On The West Coast

LOCKHEED Aircraft will move its missile systems division from Van Nuys, Calif. to new expanded headquarters in the San Francisco area by the end of 1956.

An initial outlay of $7 million will be spent for construction of two 51,000 sq ft research laboratories on a 22-acre site at Stanford University, and a 96,000 sq ft manufacturing facility on a 275-acre site, in Sunnyvale, 7 miles from the campus. Construction is scheduled to begin immediately on the two research labs, with work on the Sunnyvale plant to begin shortly. The labs are expected to be ready by fall and the plant by the end of the year.

The initial construction will be part of a $20 million expansion program to take place over the next three years.

Louis N. Ridenour, center, of Lockheed indicates site of the firm's new research buildings to Dr. F. E. Terman, right, and D. B. Adams of Stanford University

► **Boeing** — After revealing plans for an $8.5 million manufacturing and office facility of 558,000 sq ft at Renton, Wash., the Boeing Airplane Co. announced plans for a $21 million developmental center near its main plant in nearby Seattle.

The developmental center, south of the present plant and adjacent to Boeing Field, will include four main buildings and minor supporting structures which will add 1,021,000 sq ft of covered area to the Boeing operations. Certain phases of the Bomarc project (guided missiles), physical research, structural testing and experimental activities are among the functions which will occupy the area.

Largest of the new buildings will have a total floor area of 754,000 sq ft. The buildings are expected to be completed and in operation by the fall of 1957.

Beckman Instruments Establishes Shockley Semiconductor Lab.

BECKMAN INSTRUMENTS has established the Shockley Semiconductor Laboratory near Stanford University to develop and produce transistors and other semiconductor devices in the field of advanced electronics for automatic production techniques.

Headed by Dr. William Shockley, pioneer in the development of the junction transistor, as director, initial lab members include Drs. G. Smoot Horsley, formerly of Motorola and Bell Laboratories; Leo B. Valdes, formerly of Pacific Semiconductor and Bell Laboratories; William W. Happ, formerly of Raytheon and Sylvania and R. V. Jones.

William Shockley

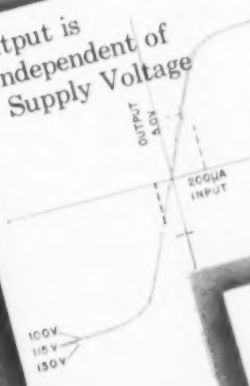
Quartered temporarily in Mountain View, Calif. the group will move into the new $500,000 research and development center Beckman is building in Stanford Industrial Park for its Spinco division and the Shockley Semiconductor Laboratory.

Completion of the facility is scheduled for August.

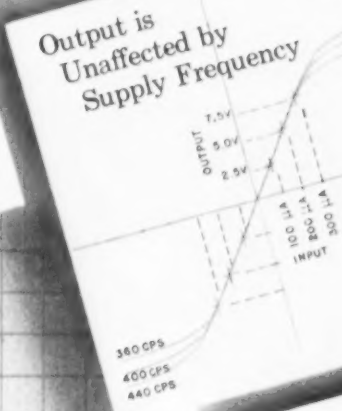
Dr. Shockley said that recent developments in physics and chemistry indicate great future expansion for semiconductors. "We have found corresponding phenomena in tran-

STABLE MAGNETIC AMPLIFIER

Output is Independent of Supply Voltage



Output is Unaffected by Supply Frequency



FERRAC

A FERRomagnetic Amplifier for Analog Computers

Ferrac, a self-contained amplifier, is now available for use in computers and controls. Initial stand off error (current into one control coil necessary to accurately zero the out-put) and null error (current into control coil to re-zero the Ferrac during environmental and operating conditions) do not exceed ±5 microamperes.

CHARACTERISTICS

INPUT: Two fully isolated 120-ohm control coils, DC polarity reversible.

OUTPUT: Unfiltered DC linear to 7.5 volts into 1000-ohm load.

GAIN: 2.5 volts output per 100 microamps into either control coil, externally adjustable by feedback.

ENVIRONMENT: Operating range -55 to +85 C, meets MIL-T-27A requirements.

POWER: 115 volts at 400 CPS

AIRPAX

DESIGNERS ENGINEERS

MIDDLE RIVER BALTIMORE 20, MD.

sistor and vacuum tube electronics which suggest ways in which transistor counterparts may be made for a wide variety of vacuum tubes now in use", he said.

General Radio Selects New President

CHARLES C. CAREY has been named president of the General Radio Co. of Cambridge, Mass. succeeding Errol H. Locke, recently retired.

Carey joined the company's production department in 1927 and has been its vice-president for manufacturing since 1944.

The following directors were re-elected: Harold B. Richmond, chairman; Charles C. Carey; Donald B. Sinclair; Arthur E. Thiessen and Frank L. Tucker.

Sprague Constructs Transistor Plant

CONSTRUCTION of a new plant for Sprague Electric Co. to manufacture surface-barrier transistors will begin shortly at Concord, N. H. The new building will occupy 20,000 sq ft adjacent to the Concord Airport.

It is expected that production will be well under way by fall of 1956 with about 200 persons employed.

Temporary manufacturing quarters in Concord will probably be utilized by Sprague beginning this spring while the new plant is being built.

Sprague was recently licensed to produce surface-barrier transistors under Philco patents.

General manager of the firm's Concord operation will be Jesse Ault, who recently retired as works manager of the Haverhill and Andover, Mass. plants of the Western Electric Co. John Puppolo, who has been associated with Sprague for the past 22 years and is presently production superintendent of the firm's tantalum electrolytic capacitor operations at North Adams, will be factory manager in charge of production. The Concord plant will be Sprague's twelfth for the manufacture of electronic components.

The company presently employs over 6,000 persons in the manufacture of various types of electronic components.

Lenkurt To Build New Engineering Building In California

ARCHITECT Frank Lloyd Wright has been retained by the Lenkurt Electric Co. of San Carlos to design a new administration and engineering building for the electronics firm.

The building will have about 90,000 sq ft of floor space and will be located near the center of Lenkurt's 55-acre plot in the San Carlos industrial area.

Neither the exact site nor the timetable for construction of the administration and engineering building is definite yet and it may be several more months before plans are complete and building starts.

Offices and engineering development laboratories that will go into the new Lenkurt building now occupy about one-third of the company's present 167,000 sq ft of floor space. The firm recently broke ground to add another 6,000 sq ft factory building wing.

Frank Lloyd Wright, center, and president L. G. Erickson, right, and executive v-p K. E. Appert of Lenkurt Electric

During the past six years the number of Lenkurt employees has increased from 125 to the present total of 1,600 and the company's monthly business volume has jumped from $100,000 to $1,500,000.

Magnavox Acquires Two Businesses, Appoints Engineers

THE MAGNAVOX CO. and Sentinel Radio Corp. signed a contract for the sale of substantially all the assets, properties and goodwill of Sentinel as a going business to Magnavox.

Magnavox expects the acquisition of Sentinel to facilitate its planned long-range expansion program. Operations at the Sentinel plant in Evanston, Ill., are expected to continue and be expanded in the near future. Leonard F. Cramer, vice-president and general manager of the television-radio-phonograph division of Magnavox, will be responsible for the Sentinel operation.

Richard S. Lawton, present secretary-treasurer of Sentinel, will continue in an executive capacity. The business will continue without interruption and production will be accelerated in the near future. Magnavox also plans to build a 100,000 sq ft plant at Urbana, Ill. with provision for eventual expansion of this operation to 400,000 sq ft. It is to be completed by the latter part of 1956.

Magnavox also completed the acquisition of the Sparks-Withington radio-television business as

STAR PERFORMER

GOOD-ALL Capacitors

contribute to the stable performance of many types of electronic equipment. Not all are as large and impressive as a TV transmitter, but their requirements for capacitor stability may be many times more exacting.

Engineers have come to rely on Good-All Mylar capacitors for their small capacity change during life. This feature, together with small size, low power factor and excellent IR, is responsible for the rapid increase in demand for our various MYLAR* types.

*DuPont's Trademark for Polyester Film

CLOSE TOLERANCE

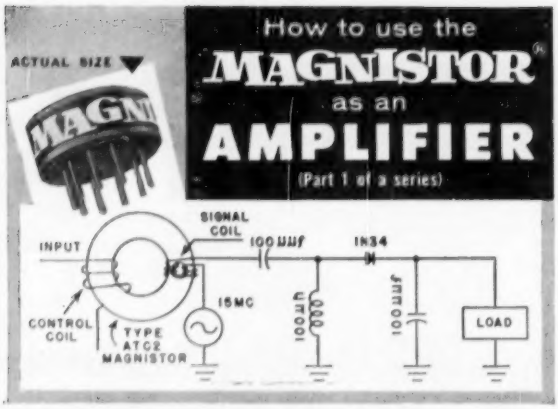
The use of close tolerance capacitors becomes practical when there is assurance that later shifts will not wipe out the advantage of initial precision. Good-All Mylar types are widely applied in tolerance of 1%, 2% and 5%. *Our engineers are ready to work with you on any capacitor problem.*

MYLAR Capacitor Applications

Computers . . . Military and Commercial
Seismic Instrumentation
Electronic Control Systems
Guidance Systems
Critical TV Circuits
Test Equipment

Want more information? Use post card on last page.

PLANTS AND PEOPLE (continued)



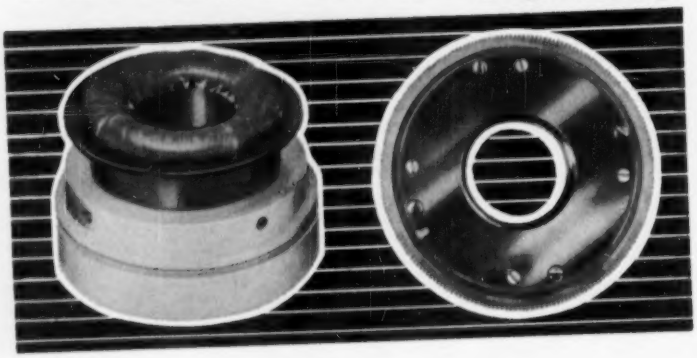
● LOW NOISE ● LONG LIFE
● RUGGEDNESS ● SMALL SIZE

. . . **high power gain and dependability** are only a few advantages of Magnistor amplifiers for low-level signals from d-c to rf frequencies. The typical circuit illustrated will deliver a 25-volt signal at 20 ma, with an output noise level equivalent to less than 2 microvolts applied to the input, and an input impedance of 50 ohms.

Using other Magnistor types and circuits, considerably higher gains can be attained. For complete information on Magnistors, their circuits and applications, write to:

Potter
POTTER INSTRUMENT CO., INC.
115 Cutter Mill Road, Great Neck, N. Y.

DEFLECTION YOKES



We specialize in the design and manufacture of precision deflection yokes for military and commercial applications. Phone or write for immediate engineering evaluation of your critical display problems.

Celco

Phone: RAmsey 9-1123

Constantine Engineering Laboratories Co.

Island Avenue **Mahwah, N. J.**

part of a planned program to increase the company's sales volume to the $100 million mark in its next fiscal year. The Magnavox Company volume for the last six months ended December 31, 1955 was $34 million. It is anticipated that the sales volume to be gained from the acquisition of the Spartan business will add from $15 million to $20 million in radio-phonograph-television annual business.

None of the manufacturing facilities of Sparks-Withington were acquired. Only certain movable assets associated with the manufacture and conduct of the Sparton radio-television business were purchased. A line of instruments will be manufactured by the Magnavox Company in its own plants and sold under the brand name of Spartan through the sales personnel previously associated with the Sparks-Withington.

Lt. Col. John J. Slattery was appointed assistant to the vice-president and general manager of the government and industrial division of Magnavox.

Prior to joining the firm, he was vice-president and director of engineering of Sterling Precision Instrument Corp., instrument division.

Colonel Loren E. Gaither, Signal Corps, USA (RET), has been appointed director of engineering of the government and industrial division of Magnavox. He was formerly with the Evans Signal Laboratory of the Signal Corps engineering laboratories of which he was director from 1951 to 1955.

Bendix Names Transistor Head

WALLACE C. CALDWELL has been appointed to head a new department for expanded research into and production of transistors at the Red Bank division of Bendix Aviation Corp.

Dr. Caldwell, who has been chief engineer of the division's electron tube plant in Eatontown, N. J. for the past four years, will direct an engineering and manufacturing program geared to the market for transistors and other semi-conductor devices.

Before joining Bendix, Caldwell

owned subsidiary. The 25,000 sq ft

was associated with the department of physics of Iowa State College and also served as a consultant to Bendix. During World War II he conducted research and development on radar systems and radar tubes at MIT.

John H. Wyman had been named to succeed Dr. Caldwell as chief engineer for electron tubes at the Red Bank division. Wyman has been with Bendix for seven years, serving most recently as chief project engineer for special-purpose electron tubes.

Bendix also announced that Richard M. Somers has been appointed director of engineering for the Kansas City division.

Prior to his appointment he was assistant director of engineering of the division, which is engaged in the production of instruments and electronic devices as a prime contractor for the Atomic Energy Commission.

He joined Bendix as a staff engineer of the Eclipse-Pioneer division, Teterboro, N. J.

Somers succeeds Howard K. Morgan who has been named director for commercial aviation systems of the corporation.

Fairchild Formally Opens New Plant

Left to right, S. M. Fairchild, Lee Griswold, J. M. Case

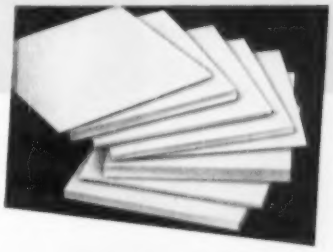
FAIRCHILD Camera and Instrument Corp. formally opened a new plant in California primarily built to provide new west coast production, engineering, sales and office facilities for the potentiometer division of Fairchild Controls Corp., a wholly-

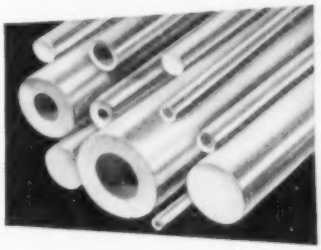
TEFLON*

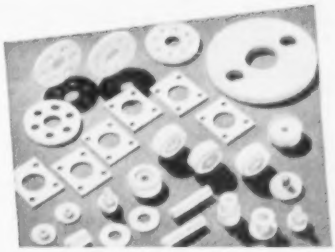
SHEET....ROD....

TUBING....MOLDED OR MACHINED PARTS?

YOU CAN GET JUST WHAT YOU WANT







from JOHN CRANE

"Made of Teflon by JOHN CRANE" has become practically a standard specification for parts and components subject to severe electrical, corrosive, thermal, mechanical or atmospheric abuse. Whatever your requirements in Teflon . . . sheet, rod, tubing, packings, gaskets, bellows, insulators, sealing discs or non-stick parts . . . "John Crane" can supply them!

In addition, you get these important *plus* factors: complete uniformity throughout, high density control, freedom from flaws and rigid adherence to your specifications.

"John Crane's" complete fabrication facilities assure you prompt delivery on *exactly* what you want —no compromise. If you have an entirely new requirement, no standard design or procedure— "John Crane's" laboratory facilities, know how, research and engineering experience go to work on *your particular* need.

Now is a good time to put "John Crane" to test. Contact Crane Packing Company today.

*TEFLON *DuPont trademark*

Advantages:

CHEMICAL—Completely inert

ELECTRICAL—Extremely low power factor
Very high dielectric strength

THERMAL—Temperature range
—300°F. to +500°F.

MECHANICAL—Strong, flexible
Weather resistant

LOWEST COEFFICIENT OF FRICTION

ABSOLUTELY NON-STICK

Crane Packing Co.,
6402 Oakton St.,
Morton Grove, Ill.,
(Chicago Suburb's)

In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

JOHN CRANE CRANE PACKING COMPANY

OFFICES IN ALL PRINCIPAL CITIES

Borg 900 Series Micropots
offer everything you want
in a potentiometer
1 Versatility — 1 to 5 gang models, single or double shaft, servo or bushing mount.
2 Permanent Accuracy — Resistance element integrally molded within housing. Leads, taps and terminals firmly encapsulated.
3 Long Life — Scanning action distributes wear across face of bar contact. Rigid, fixed lead screw.
4 Dependability — Mechanically and electrically stable. Effectively sealed against dust and moisture.
5 Absolute Linearity — Uniform resistance distribution. No external trimming required.
6 Specifications — Meets extreme commercial and military requirements for all applications.
7 Availability — Quick deliveries on production quantities.
Borg 1100 Series Micropots
Accurate, dependable, long-lived. Has 9 inch coded leads for easy installation. Offers your products a competitive price advantage.
WRITE FOR CATALOG BED-A158
BORG EQUIPMENT DIVISION
GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN
BORG
Built by Borg

owned subsidiary. The 25,000 sq ft structure also provides office facilities for the reconnaissance systems division and Fairchild graphic equipment Corp., another wholly-owned subsidiary. The plant is situated on a seven acre tract to provide ample room for future building additions.

Fairchild executives on hand for the event included in addition to Sherman M. Fairchild, board chairman, L. T. Eliel, president of Fairchild Aerial Surveys; John M. Case, executive vice-president of FCI; Richard Hodgson, FCI vice-president, and president of the subsidiary Fairchild Controls Corp.; Erwin Hale, vice-president of Fairchild Controls and general manager of the potentiometer division; E. F. Richardson, director of organization and control; Lee Griswold, manager, potentiometer division west coast; Milton A. Chaffee, director of electronics and systems research and James B. Moore, director of public relations.

Fairchild also announced that Leonard S. Hermelin was appointed executive assistant to Richard Hodgson, vice president of Fairchild and general manager of the reconnaissance systems division.

He was formerly assistant manager of the division's systems projects department.

Prior to joining the company in 1953, he was chief engineer, guided missiles division, Fairchild Engine and Airplane Corp.

New Radio-TV Firm Established In Mexico

A NEW company known as Electronica Mexicana has been organized in Mexico City by Sears Roebuck & Company and two of its suppliers; Warwick Manufacturing Corp., and Pacific Mercury of California.

Pacific Mercury and Warwick have jointly operated a factory in Mexico since July 1955.

The redesigned plant occupying 40,000 sq ft, which will make electronic components in addition to tv and radio sets, can be expanded as the need for additional manufacturing and office space arises.

The plant has a conveyorized

Miniaturized

heating tunnel for the production

About a Sawtooth, Clamping and your Efficiency...

Let's look at it this way—What features should an instrument incorporate to make your job easier, help prevent costly mistakes? Take the case of the new PRD Klystron Power Supply. Should we incorporate a sawtooth rather than a sine wave modulation? It's easier to put in a sine wave. However, a sawtooth has the definite advantage of eliminating phasing and blanking problems when the frequency response of a transmission device is to be studied. So, in goes the sawtooth. It's easy enough to get hold of some sine wave modulation which can be applied through the external modulation input.

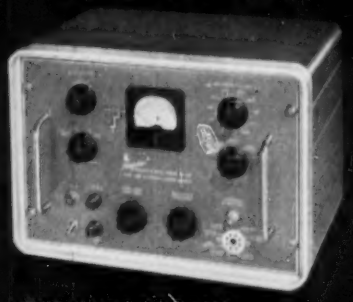
As for preventing mistakes—consider switching from cw to square wave modulation. Suppose you forget to readjust the reflector voltage . . . Sure, you'll catch the mistake later, but time is lost. The new PRD Klystron Power Supply has an electronic clamping circuit which locks the top of the square wave to the previously chosen reflector voltage. No readjustments to think about, no mistakes.

Want to modulate with pulses—use the external input. The rise time degradation of your pulses will be less than .1 microsecond!

Another point, good regulation! Here's an example: a ±10% line change or *any* load change will cause a reflector voltage change of only ±0.1%.

Compare . . . chances are that you'll send in your order for the PRD Type 809, too.

The New PRD
KLYSTRON POWER SUPPLY



HERE'S WHAT THE TYPE 809 CAN DO FOR YOU—

- Powers most low and medium voltage klystrons—up to 600 V. beam supply
- Has electronic readjustment of reflector voltage when charging from cw to square wave modulation—no errors due to forgetfulness
- Has square wave, **sawtooth** and provision for external modulation for pulses
- Affords exceptional stability and regulation at modest cost
- Price $350.00 F.O.B. New York

(Available from stock. Call or write for new Bulletin.)

Polytechnic RESEARCH & DEVELOPMENT CO., INC.
202 TILLARY STREET, BROOKLYN 1, NEW YORK
Telephone: ULster 2-6800

PRD

Midwest Sales Office:
1 SOUTH NORTHWEST HIGHWAY,
PARK RIDGE, ILL.—TAlcot 3-3174
Western Sales Office:
737-41, SUITE 7, NO. SEWARD ST.,
HOLLYWOOD 38, CAL.—HO-5-5287

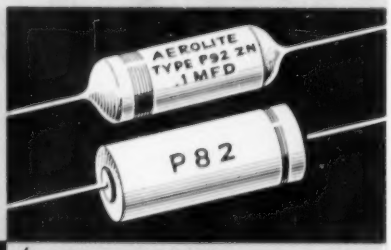
Want more information? Use post card on last page.

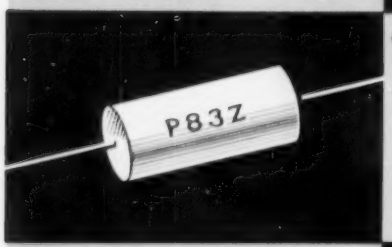
PLANTS AND PEOPLE (continued)

A. Klingenschmitt, O. F. Masin,

Miniaturized CAPACITORS FOR TRANSISTORIZED ASSEMBLIES

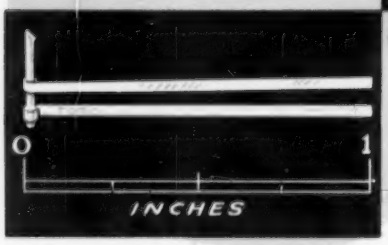
P-82 and P-92ZN CAPACITORS
Metallized-paper units—P-82, cardboard sleeve with metal end-caps and extended foil construction. Operating temperature range from —40°C to +70°C.; P-92ZN, high temperature capacitor in paper case with plastic end-fill. Operating range from —30°C to +100°C.





P-83Z CAPACITORS
Sub-miniature molded metallized-paper units in humidity-resistant molded thermoplastic case. Particularly applicable to replacement of low-capacitance paper units now in use. Operating temperature range from —15°C to +85°C. In 200-volt ratings from .005 to .04 mfd. Sizes, 3/16" d. x 3/16" l., to 1/4" d. x 5/16" l.

PWE CAPACITORS
Steatite-cased miniature aluminum-foil electrolytics, offering relatively high capacitance at low voltages. Size, only 1/4" d. x 3/4" l. Operating temperature range from —30°C to +50°C. Exceedingly low leakage currents.



CERAFIL* CERAMIC CAPACITORS
Newest and positively the smallest capacitors available anywhere. Rugged ceramic-dielectric units for operation from —55°C to +85°C. Ultra-miniature size in .001 mfd. unit is .060" d. x .290" l. Capacitances of .001 to .1 mfd. Miniature ceramic disk capacitors also available.
*Trade-mark

Transistorized assemblies demand miniature components. In some instances conventional capacitors prove adequately small; in others, new designs and materials have had to be developed. Aerovox **application engineering**, always in step with electronic trends, now offers a wide choice of **miniaturized** capacitors.

GET THE FACTS...

Complete engineering details available by writing TECHNICAL SALES DEPT., Aerovox, New Bedford, Mass.

AEROVOX CORPORATION
NEW BEDFORD, MASS.

In Canada: AEROVOX CANADA, LTD., Hamilton, Ont.
Export: Ad. Auriema., 89 Broad St., New York, N. Y. - Cable: Auriema, N. Y.

heating tunnel for the production of tv and radio cabinets. Because of the altitude, drying initially presented a difficult problem.

Dynamics Expands Reeves Instrument

REEVES INSTRUMENT CORP., a subsidiary of Dynamics Corp. of America, has taken over a $5,000,000 plant and added facilities at Roosevelt Field in Mineola, N. Y. The addition increases the company's plant space by more than 30 per cent.

The 280,000 sq ft plant will bring together under one roof Reeves research, development and production programs previously located in a number of buildings at Roosevelt Field. It will accommodate more than 3,000 employees, as compared with 1,300 in the old facilities.

The new plant will increase Reeves Instrument's total factory and office space in Mineola and New York City to approximately half a million sq ft.

Radio Club Elects Officers

Frank A. Gunther

THE Radio Club of America elected Frank A. Gunther president of the organization for 1956. Serving with him are Walter A. Knoop, Jr., vice-president; O. James Morelock, corresponding secretary; Joseph J. Stantley, treasurer, and John H. Bose, recording secretary.

Directors for the coming year include: Ernest V. Amy, Ralph R. Batcher, George E. Burghard, Paul F. Godley, Harry W. Houck, Fred

wave laboratory since it was estab-

A. Klingenschmitt, O. F. Masin, Renville H. McMann, Jr., Jerry B. Minter, Harry Sadenwater, Francis H. Shepard, Jr., Joseph J. Stantley, Jr. and Craig Walsh.

Frank A. Gunther is vice-president of Radio Engineering Laboratories in Long Island City.

Walter A. Knoop is a professional engineer in the firm of Gawler-Knoop Co. O. James Morelock is a radio consultant in Millington, N. J. Joseph J. Stantley is with Continental Sales Co., Inc., of Newark, N. J. John H. Bose is engaged in research at the electronics research laboratories of Columbia University.

GE Appoints Three Engineers

GEORGE G. GABEL has been appointed manager of the General Electric semiconductor products manufacturing operation in Syracuse, N. Y.

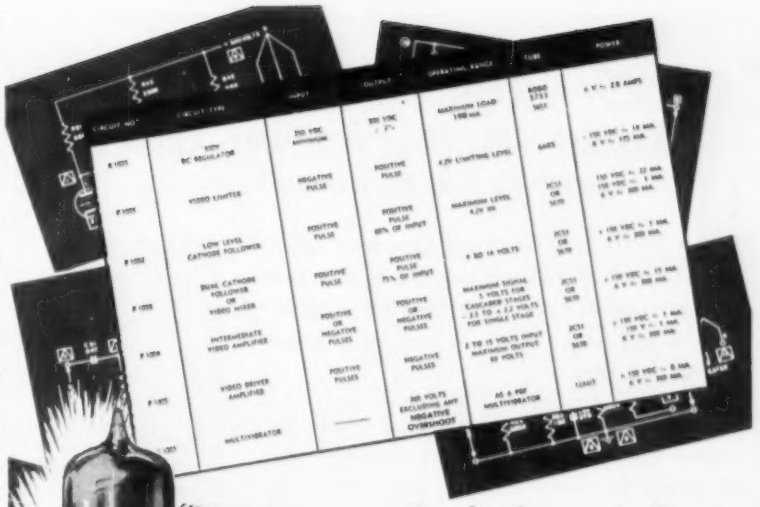
He joined GE in 1929 at Schenectady and transferred to Syracuse in 1944 as assistant superintendent of aircraft gas turbine manufacturing operations.

Immediately prior to his latest appointment, Gabel was manager of manufacturing engineering at the Clyde, N. Y., semiconductor products plant, a position he assumed in 1954.

James W. Nelson, Jr. was appointed manager, and William A. Edson, consulting engineer of GE's microwave laboratory at Stanford Industrial Park, Palo Alto, Calif.

Nelson succeeds H. R. Oldfield, Jr. who has been manager of the micro-

J. W. Nelson, Jr.



Available Now...

AEROVOX MODULIZED

STANDARD CIRCUITS

For the first time, the design engineer, experimenter, prototype technician and special-equipment builder can enjoy the advantages of basic circuit assemblies in the form of neat, compact, high-reliability modules. Instead of gathering, designing, wiring and testing the various components that go into basic circuitry, the user now has all that work done for him with these handy plug-in **Aerovox** modules, thereby permitting better utilization of time and talents towards more creative design requirements.

Selecting the most popular basic circuits with corresponding sub-assemblies, **Aerovox** now offers, through its parts distributors, seven standard-circuit modules. As a further convenience in selecting and connecting these modules, **Aerovox** makes available a 12-position printed-wiring breadboard with connection jacks and bus bars.

Individual standard-circuit modules, mounting sockets, breadboard, may be purchased separately. **Complete kit** containing seven standard-circuit modules, breadboard, banana plugs and instruction manual, in handsome plastic box, available at **special introductory price.**

WRITE FOR BROCHURE and name of nearest Aerovox distributor.

MODULE DIVISION

AEROVOX CORPORATION

DISTRIBUTOR SALES DIVISION, NEW BEDFORD, MASS.

In Canada: AEROVOX CANADA LTD., Hamilton, Ont.
Export: Ad Auriema, 89 Broad St., New York, N. Y., Cable: Auriema, N. Y.

THREE PHASE
VARIABLE FREQUENCY POWER SUPPLY
CONTINUOUSLY VARIABLE FROM 360 TO 440 CPS

CML's Model 1450 Electronic Generator has a power output of 750 volt-amperes with output voltage regulation of better than 2% from no load to full load. Harmonic content is below 3% at full load.

Model 1450 is also available as a fixed frequency unit employing a tuning fork oscillator to give a frequency accuracy and stability of 1 part in 50,000. This stability is independent of line voltage or frequency.

Catalogue sheet "P" describes the Model 1450 and is available for the asking.

COMMUNICATION MEASUREMENTS LABORATORY, INC.
350 LELAND AVE., PLAINFIELD, N. J.

FERRITE COMPONENTS by CANOGA

HIGH-POWER DOUBLE TERMINATION LOAD ISOLATOR Model 34305
HIGH-POWER DIFFERENTIAL ABSORBER Model 35776
HIGH-POWER SINGLE TERMINATION LOAD ISOLATOR Model 34304
HIGH-POWER ISOLATOR-DUPLEXER Model 35607
DOUBLE TERMINATION POLARIZATION CIRCULATOR Model 6332

Experience, skill and technical know-how has made Canoga Corp. a leader in the microwave field. The components illustrated and described are representative of Canoga's continuing progress in research and design...dedicated to serving and benefiting the microwave engineer

Write today for complete specifications and other detailed information.

CANOGA CORPORATION
Radar Systems • Antennas • Receivers
Test Equipment • Microwave Components
8963 SEPULVEDA BLVD., VAN NUYS, CALIFORNIA

wave laboratory since it was established in late 1954. Oldfield was recently promoted to general manager of a newly-established industrial computer section in Syracuse, N. Y.

Prior to his new appointment, Nelson was manager of electron tube research of the microwave laboratory. He has been with the company's electronics division since 1946, and was a member of the management team which established the Laboratory.

As consulting engineer, a new position in the microwave laboratory, Dr. Edson will be responsible for advice and counsel on technical aspects including planning for the future. He has been manager of microwave techniques at the laboratory since August, 1955, when he joined General Electric.

He came to the laboratory from Stanford University where he was acting professor of electrical engineering. Prior to this he was director of the school of electrical engineering at Georgia Institute of Technology.

Ramo-Wooldridge Plans Expansion

RAMO-WOOLDRIDGE CORP. plans the erection of a major electronics manufacturing plant in the Denver area.

It exercised an option on 640 acres of industrial land near Littleton, Arizona. Ground will be broken in May or June on the first structure of 172,000 sq ft, with allowance for future expansion of the site, if needed.

Original production in the new factory will be electronic systems for military customers, such as fire control systems for military aircraft, radar systems, electronic computers, or advanced communications equipment. Later, the company expects to produce automation and data processing equipment for commercial clients, as well.

The facility will accommodate 1,500 employees, with annual sales of $25 million.

Buildings currently occupied or under construction by Ramo-Wooldridge in the Los Angeles International Airport area total 300,000 sq ft.

Employment has grown from

Semiconductor engineers find new opportunities at Delco Radio!

Delco Radio, first organization to develop and use Hi-Power transistors for automotive application, now offers permanent employment opportunities to men of highest caliber.

Some of these opportunities are for men experienced in solving problems of semiconductor processing, development, or application. Other positions exist for persons experienced in semiconductor or related research.

These are challenging jobs where professional knowledge will be utilized to the highest degree. Qualified persons will be rewarded with personal satisfaction, recognition and stimulating companionship with other eminent scientists, and will also receive liberal compensation and benefits as important members of the General Motors organization.

If you are capable of assuming the responsibility of leadership and are experienced in transistor, diode, photo cell or other semiconductor projects, write to Personnel Director, Department B Your inquiry will be held in confidence.

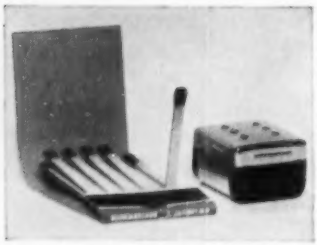
WORK WITH THE MEN WHO FIRST MADE HI-POWER TRANSISTORS AVAILABLE IN AUTO RADIOS!

Relocation expenses are paid to pleasant Indiana community where you'll make congenial associations with men of recognized standing in the field of semiconductors.

GM GENERAL MOTORS

Delco Radio

DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA



TELEX Mini-Mike®

- Tiny, precision speaker-microphone.
- Quality, dynamic performance.
- For use in dictating machines, transceivers, other electronic equipment where "ruggedness" is important.

Model 100 PRECISION DESIGN Wt. approx. 1¼ oz; Size 1"x1"x¾"; Impedance 10 ohms

TELEX Boom-Type Headset

NEW For airline reservation boards, telephone operators, television floormen.

- Lightweight . . . adjustable tone arms . . . no ear muffs.
- Available with single, double receivers, split phones.

A **TELEX** Electronic Achievement

TELEX, INC.

Electro-Acoustic Division, Telex Park, St. Paul 1, Minnesota

Manufacturers of the World's Finest Precision Miniature Electronic Equipment

The **MODERN WAY** *is to . . .* *Make it* **COUNT!**

Durant Sales Engineers will supply a PRODUCTIMETER for every machine your company designs and manufactures.

Send for Bulletin #101

DURANT MANUFACTURING CO.

1912 N. Buffum St., Milwaukee 1, Wis.
112 S. Water St. Providence 3, R. I.

Representatives in Principal Cities

PRODUCTIMETERS SINCE 1879 *Count Everything*

150 in July, 1954, to nearly 1,400 currently. By December, 1956 employment is expected to exceed 2,300.

Sales for the company totalled $10,000,000 in 1955 vs. $2,000,000 in 1954. Sales this year are expected to exceed $20,000,000.

Philco Names New President

JAMES H. CARMINE will retire as president of Philco Corp. when his term ends in April. He plans to continue as an active member of the company's board of directors and finance committee and to serve as special consultant on sales and merchandising. He joined Philco in 1923 as a battery salesman.

William Balderston, who has been associated with Philco for 25 years, is to be re-elected chairman of the board. James M. Skinner, Jr., who is now a director and vice-president and general manager of the television division, is to become president.

Skinner, son of the late James M. Skinner, who was president of Philco from 1929 to 1939, joined the company in 1934.

Gunderson Receives Amateur Award

Left to right, J. Milton Lang of GE, under secretary of state Herbert Hoover, Jr., Robert W. Gunderson

ROBERT W. GUNDERSON, a blind New York City radio amateur, was presented with the Fourth Annual Edison Radio Amateur Award for outstanding public service.

He received the trophy and $500 check for designing electronic test

BRUSH *...complete systems for noise or vibration measurement*

21 seconds to make complete noise or vibration analysis!

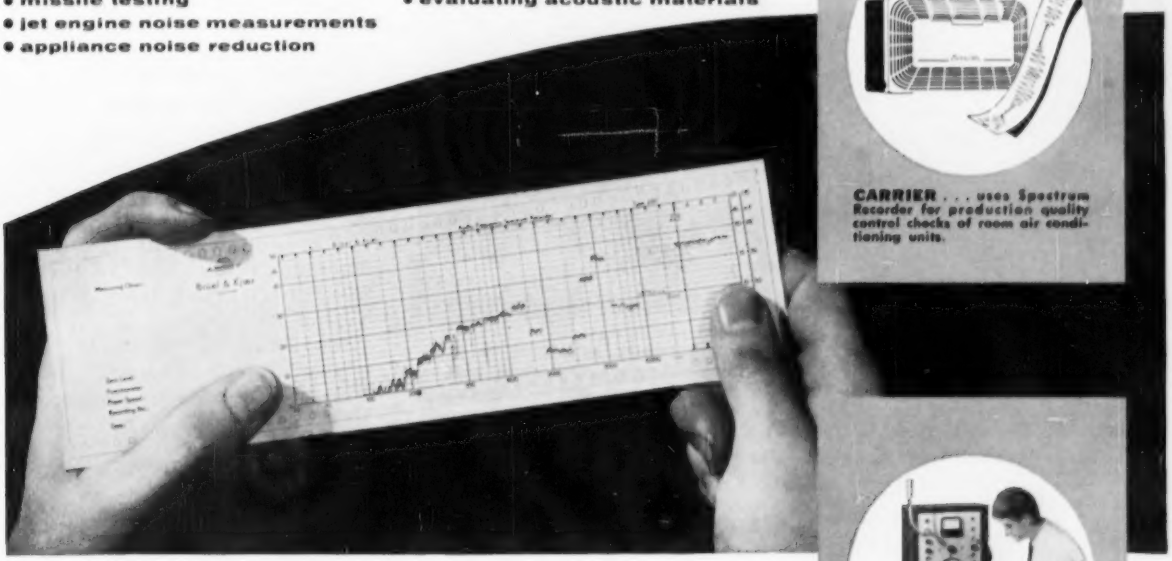
This chart record produced by the Brush Spectrum Recorder presents a complete frequency and noise level analysis for an electric motor. It is an example of the way Brush instrumentation can aid *your* analysis of noise or vibration:

- **All sounds from 14 cycles to 36,000 cycles per second automatically scanned and recorded by the Brush Spectrum Recorder to eliminate laborious plotting of data.**
- **Measurements made in one-third octave steps, to positively identify frequencies.**
- **Complete recording through the complete frequency range made in 21 seconds, to save valuable engineering time.**

The Spectrum Recorder is one unit in the most complete line of noise and vibration instrumentation available (manufactured in Denmark by Bruel & Kjaer). Thus Brush can offer you matched systems, and offer application assistance on complete projects. For complete information call your Brush representative, or write Brush Electronics Company, Dept. K-4, 3405 Perkins Avenue, Cleveland 14, Ohio.

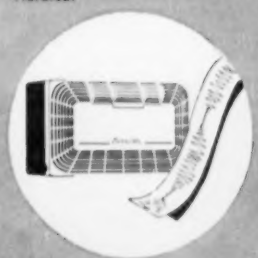
How leading companies use this Brush instrumentation

- engine vibration analysis
- aircraft noise reduction
- accelerometer calibration
- missile testing
- jet engine noise measurements
- appliance noise reduction
- automotive vibration analysis
- tape recorder readout
- plant noise studies
- evaluating acoustic materials



LOCKHEED . . . uses Spectrum Analyzer for data reduction of telemetered information . . . and to measure noise transmission through aircraft fuselage wall panels.

GENERAL ELECTRIC . . . uses Frequency Response Recorder to check mechanical resonance points of both steam and jet turbines when blades are magnetically vibrated.



CARRIER . . . uses Spectrum Recorder for production quality control checks of room air conditioning units.

SPECTRUM RECORDER is integrated system for noise and vibration recording in one-third octave steps.

BRUSH ELECTRONICS COMPANY

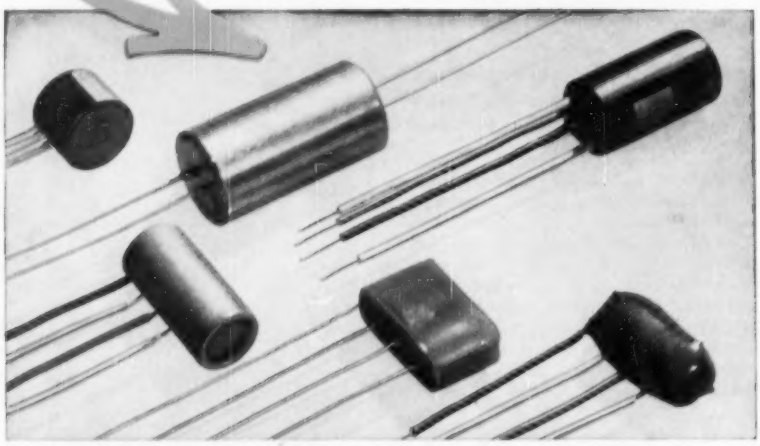
INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

BRUSH ELECTRONICS

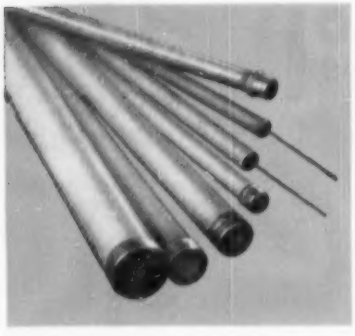
Division of Clevite Corporation

UNION

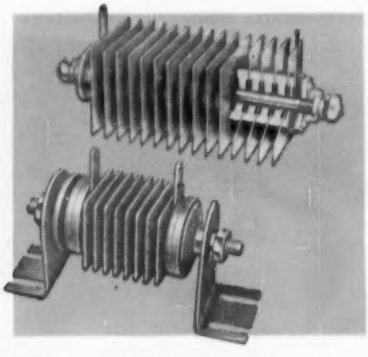
SELENIUM RECTIFIERS
fitted to your application



SPECIALLY DESIGNED COMBINATIONS of standard UNION selenium rectifier cells range in size from ⅛" to ½" diameter rated from 2.5 to 40.0 milliamperes per cell on a single-phase full-wave bridge basis.



"SELENIUM SLIMS" in five ratings ranging from 1.25 to 20.0 milliamperes and maximum peak inverse voltages from 36 to 9360 with condenser input filter. Available in diameters from ⅛" to ½".



POWER RECTIFIERS with solid stack assembly range in size from 1" x 1" to 5" x 6" and with convection cooling are rated from .80 to 10.0 amperes per cell on a single-phase full-wave bridge basis.

Our engineers can help you in designing the best rectifier for your applications. Write for catalog.

GENERAL APPARATUS SALES
UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
PITTSBURGH 18 PENNSYLVANIA

instruments which operate by sound instead of visual meters. The annual award is granted each year by General Electric Co. for ingenuity and sacrifice displayed in employing amateur radio in the public interest.

Speakers at the award banquet in Washington, D. C. included Herbert Hoover, Jr., the undersecretary of state, himself a licensed radio amateur.

Gunderson is editor of The Braille Technical Press, an electronics magazine for the blind, and has translated electronics reference books into Braille.

Mallory To Acquire General Dry Batteries

P. R. MALLORY plans to acquire the business of General Dry Batteries.

General Dry is to operate as a Mallory division under its present management. In addition to president Walter A. Onorato, General Dry's officers include Fielder Israel, executive vice-president, and Dudley Thomas and Frank J. Wisinger, vice-presidents.

Motorola Extends Arizona Expansion

A $3 million plant expansion for its Phoenix, Ariz., research and production facilities is planned by Motorola.

The new plant site is on 160 acres 2 miles southeast of Scottsdale, resort center about 9 miles west of Phoenix.

The additional 150,000 sq ft of production and laboratory space will bring total plant space of Motorola's three Phoenix facilities to 300,000 sq ft.

Work in the new plant will be devoted to research, development, and production of military electronic equipment. This plant will parallel production of one of the two other Motorola divisions in Phoenix. The company's third plant, a $1.5 million structure, produces transistors for military and civilian use.

When completed, the new facility will employ a work force of 1,000 —divided into about 400 engineers and physicists and about 600 as-

sembly and production workers. Motorola now employs 2,000 at its two other facilities at Phoenix.

When all three plants are in production, the company payroll will top $1.5 million a month making it one of the largest in the state.

Westinghouse Promotes Five Engineers

GILBERT C. LARSON has been appointed assistant general manager of the television-radio division of Westinghouse.

He was employed by the Colonial Radio Corp. in 1935 as supervisor of the production engineering laboratory. From 1940, he was with the Hazeltine Electronics Corp. as a project engineer on iff gear, and later, as engineer in charge of the New York licensee laboratory. He joined Westinghouse in December 1947. Prior to his new appointment, he was manager of engineering for the television-radio division.

Norman S. Kornetz has been appointed manager of engineering of the division. He was formerly manager, engineering sub-division, where he had direct responsibility for all television engineering.

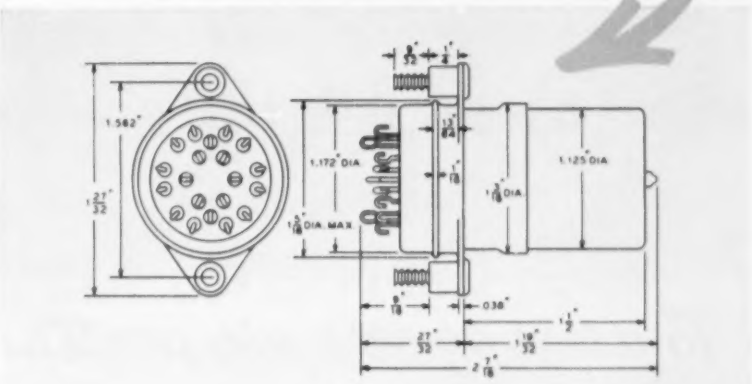
He was a radio receiver design engineer with the Colonial Radio Corp. from 1938 through 1942. In 1942 he became a captain in the U. S. Signal Corps and was in charge of the government's administrative radio communications at Calcutta, India, until 1945.

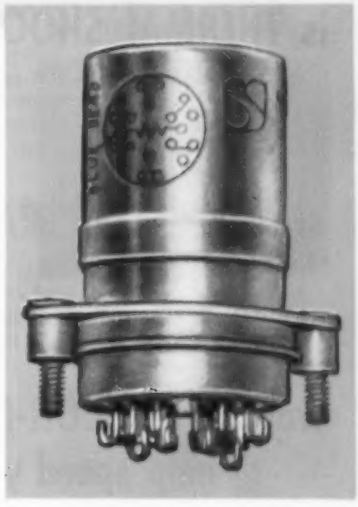
He joined Westinghouse in 1945 as manager of television engineer-

Norman S. Kornetz

UNION

MINIATURE RELAY
Plate Circuit 10,000 OHMS





THIS NEW UNION 10,000 ohm, current-sensitive relay picks up at a nominal value of 8 milliamperes throughout the entire temperature range of −65°C to +125°C, while maintaining the excellent shock and vibration characteristics inherent in our standard design. It can withstand 200 volts across the coil continuously.

These current-sensitive relays have a life expectancy of 100,000 operations. They meet or exceed all requirements of Mil-R-5757-B and withstand shock up to 50G's, vibration through 1500 cycles at 15G's.

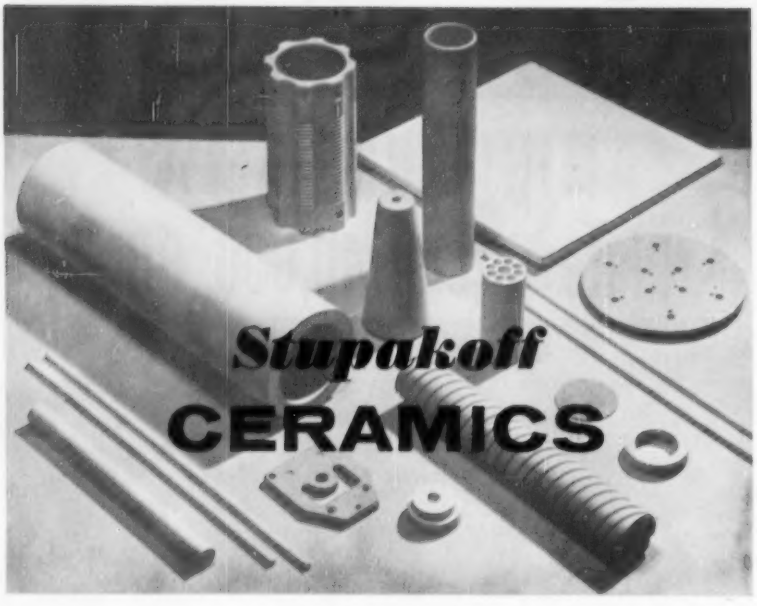
The relays are available in 6PDT or 4PDT models, all the usual mountings and with plug-in or solder-lug connections.

DRY CIRCUITRY APPLICATIONS

In grid switching applications where the relay contacts must operate at low-voltage, low-current levels, special gold-alloy contacts have proved highly reliable. They maintain their low resistance through hundreds of thousands of operations. They are available on the complete line of UNION miniature relays.

GENERAL APPARATUS SALES
UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
PITTSBURGH 18 PENNSYLVANIA

Want more information? Use post card on last page.



To users of ceramic parts...

is THERMAL SHOCK giving you trouble?

Stupakoff offers a number of ceramic bodies providing exceptional resistance to thermal shock, the most outstanding being STUPALITH, which has withstood over a hundred cycles from 2000° F to liquid air without harm.

are HIGH TEMPERATURES your problem?

Components formed of selected Stupakoff Ceramic Materials will withstand extremely high and prolonged temperatures, without deterioration, even in the presence of many corrosive gases and materials.

would PRECISION-MADE CERAMICS help speed your production?

Stupakoff specializes in the mass-production of precision-made ceramic parts and components. Tolerances of ±0.001 in. are not unusual. Their use in assemblies of electrical and electronic equipment sharply reduces assembly costs, and assures correct functioning of the equipment in service. This precision is particularly valuable in miniaturized assemblies.

Write for the new Stupakoff Ceramic Data Chart

Stupakoff
DIVISION OF

Write Dept. E
LATROBE, PENNSYLVANIA

The CARBORUNDUM Company

ing, a position he held until his new appointment.

Three other promotions were made in the engineering department of the television-radio division of Westinghouse.

J. P. Van Duyne was appointed as manager, engineering sub-division. In his new position he will have responsibility for all television engineering. He was formerly in charge of color television engineering. He has been with the company since 1953.

O. H. Fernald was appointed supervising engineer in charge of color television engineering. He has been with Westinghouse since 1951. He will report to Van Duyne.

A. S. Goldsmith was appointed as supervising engineer in charge of all radio engineering. He has been with the firm since 1949. He will report directly to N. S. Kornetz.

Olympic Radio Acquires Bogen

OLYMPIC Radio & Television purchased for cash all of the outstanding stock of David Bogen Co., of New York, N. Y.

The Bogen Company, for its fiscal year ended June 30, 1955, reported net sales of $4,583,895, and a net profit, after taxes, of $157,222.

The present management of Bogen will continue in charge of its operations and the brand name, sales organization and the pattern of distribution will remain intact.

Western And AB-PT Expand In Electronics

WESTERN UNION and American Broadcasting-Paramount Theatres each plan to acquire a 22 per cent interest in Technical Operations of Arlington, Mass., a manufacturing, research and development organization. Both firms are to have options to increase their individual stock interest up to 25 per cent each.

Technical Operations is engaged in the application of nucleonics, operations research, chemistry, physics and electronics to industry and government uses.

Last April the telegraph company purchased a one-third interest

in Microwave Associates, of Boston. AB-PT previously was associated with Microwave and presently has a one-third interest in that company.

Technical Operations was formed in March, 1951. Its officers include three of the original founders: Dr. Frederick C. Henriques, Dr. Eric T. Clarke and Dr. Marvin G. Schorr.

Burroughs Appoints Engineering Director

Thomas M. Butler

THOMAS M. BUTLER has been appointed to the new post of director of engineering for Burroughs Corp. He was formerly chief development engineer.

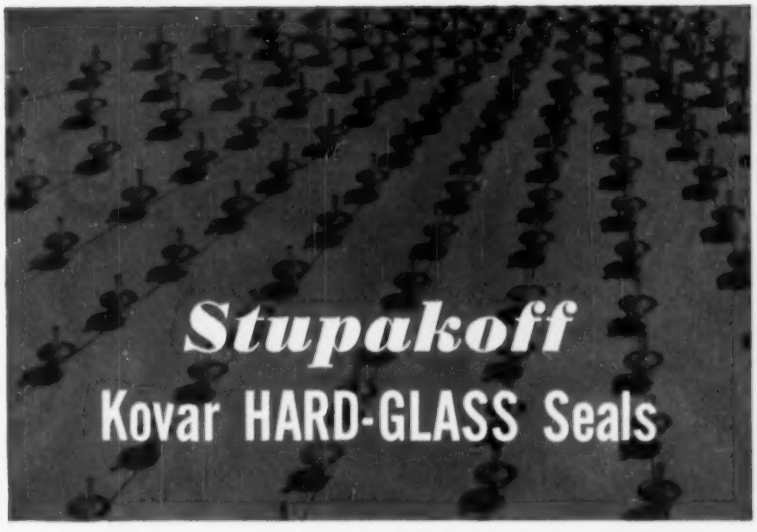
He assumes responsibility for the administration of all engineering functions at the home office in Detroit. In addition he will be responsible for functional engineering coordination of product engineering in all divisions and subsidiaries.

Butler has been with the corporation for 37 years. He joined Burroughs in 1919 as a tool design apprentice under its apprentice program.

Chope Named Outstanding Engineer

WILBERT E. CHOPE, president of Industrial Nucleonics Corp. of Columbus, Ohio has been named the "Outstanding Young Electrical Engineer of 1955" by the jury of award of Eta Kappa Nu, electrical engineering honorary fraternity.

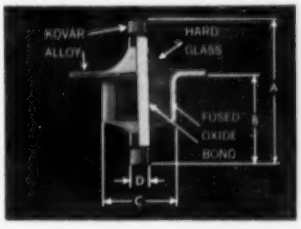
This award is made annually to an electrical engineer under 35 and



PERFECTLY FUSED BOND eliminates "leakers"

The single terminal hermetic seals shown here are among the most widely-used of literally hundreds of designs of Stupakoff Kovar Hard-Glass designs.

At the right is a typical cross-section showing how hard glass and Kovar alloy are intimately fused in an oxide bond that forms a true hermetic seal. Because the thermal expansion of Kovar exactly matches that of hard borosilicate glass, Stupakoff Seals are free from strain over the entire working temperature range.



Principal sizes available are:

Dimension A
Over-all length..... .220 in. to 3 7/16 in.
Dimension B
Flange to lead end.... .110 in. to 2 7/16 in.
Dimension C
Cup diameter..... .119 in. to .625 in.
Dimension D
Terminal diameter.... .015 in. to 3/16 in.
Special sizes can be made if desired.

Terminals may be solid or tubular, with plain ends, or with flattened and punched or hook ends, as shown in the photograph.

WRITE for catalog 453A, which gives complete data and dimensions of all standard Stupakoff Kovar Hard-Glass Hermetic Seals.

Representative terminal designs are illustrated above.

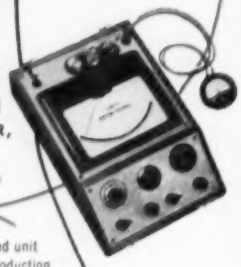
Stupakoff
DIVISION OF
The CARBORUNDUM Company

Write Dept. E
LATROBE, PENNSYLVANIA

Want more information? Use post card on last page.

marion
advancement in instrument design

NO DOUBT ABOUT IT



. . . with the versatile
MULTI-RANGE METER TESTER,
Power Supply,
and
Limit Bridge

Precise, self-contained unit for laboratory and production use. For DC instrument calibration from 25 ua full scale to 10 ma full scale, and 0-100 V DC; sensitivity and resistance measurement; DC current-voltage source; limit or Wheatstone bridge measurements from 0-5000 ohms. Regulated Power supply. Stepless vacuum tube voltage control. Accuracy exceeds ¼% (current), ½ ohm or ½% (resistance). For 115 V, 60 cycle AC. Complete — needs no accessories.

marion meters

marion electrical instrument company
GRENIER FIELD, *New Hampshire's NEW Air-Industry Area*
MANCHESTER, N. H., U. S. A.

copyright 1956 M. E. I. Co.

designed for Tomorrow

New ILLINOIS TYPE SMT
SUB-MINIATURE
Electrolytic Capacitors

Where space is at a premium—and absolute reliability is a must—there you will find ILLINOIS type SMT subminiature electrolytic capacitors.

- Immune to shock and vibration.
- Ideal for low voltage DC circuits.
- Hermetically sealed — Immersion - proof aluminum cases.
- Securely anchored "double sealed" construction.
- Extended temperature ranges.

If your application is a "tough one", specify ILLINOIS Type SMT for complete dependability. Wide range of capacities and voltages.

ILLINOIS CONDENSER CO.
1616 N. THROOP STREET
CHICAGO 22, ILLINOIS

Want more information? Use post card on last page.

out of the college less than 10 years in recognition of outstanding technical accomplishments and meritorious service in the interests of his fellowmen.

Honorable mentions were made to J. N. Grace of the Westinghouse Atomic Power Division; H. R. Johnson of Hughes Research Laboratories; D. B. Shuster of the Sandia Corporation and Glen Wade of the Stanford University Applied Electronics Laboratory.

With Henry R. Chope and George B. Foster, Chope founded the Industrial Nucleonics Corp. in 1950 to develop peace-time industrial uses of atomic energy. Starting with three men and zero sales, this company now employs close to 300 people and is a multi-million dollar corporation.

North American Selects Two Engineers

NORMAN F. PARKER has been appointed assistant chief engineer of autonetics, a division of North American Aviation.

Prior to his appointment, Dr. Parker served for four years as assistant chief of the division's guidance section. He first joined the company in 1948.

He was appointed supervisor of the theoretical analysis unit in 1950 and in 1951 was promoted to group leader, autonavigator systems group. He held the latter position

Norman F. Parker

until 1952 when he was named assistant chief of the guidance section.

Prior to joining North American he was employed as an engineer at the University of California radia-

3 ANSWERS TO POWER PROBLEMS

More flexible shafts are being used in the electronic field today because they offer an economy in time, space, and costs.

There are three types of flexible shafts available, each having certain advantages of its own.

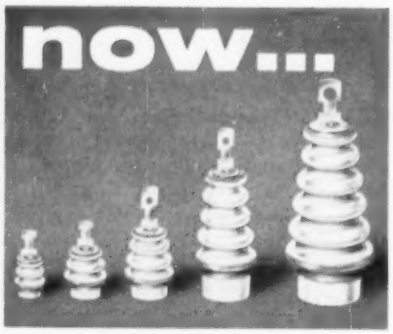
The FIRST type of flexible shaft is power drive, which transmits power between two points where, due to position, solid shafts cannot be used. The power drive flexible shaft provides for rotation either clockwise or counter-clockwise with the wire wound according to the direction rotation in order to strengthen the cable while the assembly is in use.

SECOND is the remote control flexible shaft which offers the advantage of rotation both clockwise and counter-clockwise and may function in either a continuous or an intermittent operation. The remote control flexible shaft has proven its value many times where the driven element required only a fraction of a turn or many complete turns and where both rotation and reciprocation were required.

The THIRD type of flexible shafting is the coupling which is an added application of the remote control flexible shaft and is most useful to control the movement of parts within a piece of equipment. There are no alignment problems to contend with because the flexibility of the coupling compensates for any difference in alignment between the drive and the driven elements.

For complete information and a better understanding of flexible shafting write F. W. Stewart Corporation, 4311 Ravenswood Ave., Chicago 13, Illinois.

now...



Frenchtown Metallized Terminals!

Here is Frenchtown's improved line of Annuluted Type NICOTE Metallized Hermetic Terminals for use in controls, relays, transformers, capacitors, motors, and heater units. Custom-engineered of HIGH ALUMINA CERAMICS and metallized with our exclusive NICOTE, these terminals are available in six varying sizes with a choice of terminal hardware to fit any exacting application. Write for Engineering Bulletin 1055.

frenchtown PORCELAIN COMPANY
86 Muirhead Avenue • Trenton 9, N. J.
National Representatives: Lundey Associates
694 Main St., Waltham 54, Massachusetts

Want more information? Use post card on last page.

HOW ARE YOUR COMMUNICATIONS ?

Do the booklets, pamphlets, and manuals you use really *work* for you? Are these vital publications, that tell the story of your products and your company, as effective, readable, well designed and illustrated as they can be? Today more than ever, your entire operation is judged by each annual report, employee manual, and public relations piece that you produce. Have you examined your communications lately? If you have any doubt as to the impact of your instructional and promotional literature, remember . . .

COMMUNICATION IS OUR BUSINESS

For a good many decades McGraw-Hill has stood for complete coverage in the business literature field. Now the McGraw-Hill TECHNICAL WRITING SERVICE offers a new approach to your publication problems — an *integrated* writing, editing, illustrating, and printing service for the *custom* production of: INSTRUCTION MANUALS, PRODUCT BULLETINS, TRAINING AIDS, INDUSTRIAL RELATIONS LITERATURE, ANNUAL REPORTS, COMPANY HISTORIES, PROCEDURAL GUIDES and other collateral literature. More than 150 editorial and graphic experts are at your disposal, ready to prepare high-quality material to your own or government specifications. Save time, save money . . . and make your communications work! Let *our* staff be your staff for technical and business publications.

McGraw-Hill Book Co. TECHNICAL WRITING SERVICE

Write or phone Technical Writing Service, McGraw-Hill Book Co., Inc.
330 West 42nd Street, New York 36, N. Y. • LOngacre 4-3000

This service is available through ad agencies.

★ ULTRA LOW capacitance & attenuation

TYPE	μμF/ft	IMPED.Ω	O.D.
C 1	7.3	150	.36"
C 11	6.3	173	.36"
C 2	6.3	171	.44"
C 22	5.5	184	.44"
C 3	5.4	197	.64"
C 33	4.8	220	.64"
C 4	4.6	229	1.03"
C 44	4.1	252	1.03"

WE ARE SPECIALLY ORGANIZED TO HANDLE DIRECT ORDERS OR ENQUIRIES FROM OVERSEAS
SPOT DELIVERIES FOR U.S.
BILLED IN DOLLARS—SETTLEMENT BY YOUR CHECK
CABLE OR AIRMAIL TODAY

NEW 'MX and SM' SUBMINIATURE CONNECTORS Constant 50Ω 63Ω 70Ω impedances

TRANSRADIO LTD. 138A Cromwell Rd. London SW7 ENGLAND CABLES: TRANSRAD, LONDON

for service and lab. work

Heathkit
PRINTED CIRCUIT
OSCILLOSCOPE KIT
FOR COLOR TV!

① Check the outstanding engineering design of this modern *printed circuit* Scope. Designed for color TV work, ideal for critical Laboratory applications. Frequency response essentially flat from 5 cycles to 5 Mc down only 1½ db at 3.58 Mc (TV color burst sync frequency). Down only 5 db at 5 Mc. New sweep generator 20-500,000 cycles, 5 *times* the range usually offered. Will sync wave form display up to 5 Mc and better. Printed circuit boards stabilize performance specifications and cut assembly time in half. Formerly available only in costly Lab type Scope. Features horizontal trace expansion for observation of pulse detail — retrace blanking amplifier — voltage regulated power supply — 3 step frequency compensated vertical input — low capacity nylon bushings on panel terminals — plus a host of other fine features. Combines peak performance and fine engineering features with low kit cost!

MODEL O-10
$69.50*
Shpg. Wt. 27 lbs.

Heathkit TV
SWEEP GENERATOR KIT
ELECTRONIC SWEEP SYSTEM

② A new Heathkit sweep generator covering all frequencies encountered in TV service work (color or monochrome). FM frequencies too! 4 Mc — 220 Mc on fundamentals, harmonics up to 880 Mc. Smoothly controllable all-electronic sweep system. Nothing mechanical to vibrate or wear out. Crystal controlled 4.5 Mc fixed marker and separate variable marker 19-60 Mc on fundamentals and 57-180 Mc on calibrated harmonics. Plug-in crystal included. Blanking and phasing controls — automatic constant amplitude output circuit — efficient attenuation — maximum RF output well over .1 volt — vastly improved linearity. Easily your best buy in sweep generators.

MODEL TS-4
$49.50*
Shpg. Wt. 16 lbs.

Heath COMPANY
A SUBSIDIARY OF DAYSTROM, INC.
BENTON HARBOR 14, MICH.
WRITE FOR FREE CATALOG ...COMPLETE INFORMATION

tion laboratory at Oak Ridge, Tenn.

D. B. Duncan has been appointed assistant chief of the guidance section, succeeding Parker.

Dr. Duncan first joined autonetics in August, 1950 as a research engineer in the guidance section's investigation unit. In August, 1954 he was promoted to group leader of the guidance analysis group. Due to a reorganization, he became group leader of the section's research group in July, 1955 and held that position until his recent appointment.

Servomechanisms Promotes Kasindorf

IRA L. KASINDORF has been appointed chief development engineer of Servomechanisms eastern components division in Westbury, N. Y.

Prior to his appointment, he was a staff engineer at the company's eastern division for three years, where he was engaged in the development of analog computers and associated electronic and electromechanical components.

Telecomputing And Whittaker To Merge

TELECOMPUTING CORP. plans to acquire all of the outstanding stock of Whittaker Gyro, in exchange for 900,000 shares of authorized but unissued Telecomputing stock.

Telecomputing will specialize in scientific data processing equipment, commercial products and military products for guidance and control systems.

Telecomputing Corp. was formed in 1947 by Ward Beman and other associates. Whittaker Gyro and predecessor companies have been in business since 1938.

The management of Telecomputing Corp. will consist of Ward Beman as chairman of the board and Joseph Globig as president. Globig was formerly president of Whittaker Gyro.

Telecomputing's plant facilities consist of approximately 146,000 sq ft and total personnel of about 800.

Current backlog of the combined companies is approximately $9,000,000.

Wm. R. Whittaker Co., Ltd.,

parent company to Whittaker Gyro, will be the principal stockholder of Telecomputing Corp.

Ballard Joins Hall-Scott Motors

ALBERT N. BALLARD, has joined Hall-Scott Motors Co. as factory manager of the firm's electronics division in Burbank, Calif.

For 17 years he served in supervisory capacity for Convair Corp. In January, 1952, he became aircraft division manager of the White Motor Co. and later that year returned to Convair as chief industrial engineer.

Stanford Research Appoints Two

Frederick E. Terman

FREDERICK E. TERMAN, dean of the school of engineering and provost of Stanford University, has joined the board of directors of Stanford Research Institute as a member and vice-chairman.

Except for three years service with the Radio Research Laboratory at Harvard, Dr. Terman has been a member of the Stanford faculty since 1925.

Stanford also announced that Edgar A. Post, former superintendent of navigational aids for United Air Lines, has been appointed manager of the radio systems laboratory.

He will supervise the engineering division's research in electronic

Improved regulation

Oregon Electronics
MODEL B3

The Model B3 Variable Voltage Regulated Power Supply is an improved version of the standard time-tested Model A3.

REGULATION: against load .15%
against line .3%

CONTINUOUSLY VARIABLE, 0 to 350 volts DC

CURRENT: 200 milliamperes.

RIPPLE less than 3 millivolts peak to peak at any current or voltage. Either positive or negative output terminal may be grounded

VARIABLE stabilized bias supply.

Continuously Variable... without switching

Oregon Electronics
MODELS
5-2V & 5-4V

Models 5-2V and 5-4V Variable Voltage Regulated Power Supplies provide extremely well filtered and regulated direct current output which may be varied continuously without switching from zero to 500 volts. Maximum current output of the instruments may be drawn at any voltage setting.

REGULATION: against load .15%
against line .3%

CONTINUOUSLY VARIABLE, 0 to 500 volts without switching

CURRENT: 200 milliamperes (any voltage setting) (5-2V).
400 milliamperes (any voltage setting) (5-4V)

EITHER POSITIVE OR NEGATIVE output terminal may be grounded.

RIPPLE VOLTAGE less than 5 millivolts peak to peak

VARIABLE stabilized bias supply.

Oregon Electronics
2232 EAST BURNSIDE STREET
PORTLAND 15, OREGON
BEImont 6-9292

MANUFACTURERS OF SPECIAL ELECTRONIC EQUIPMENT

Want more information? Use post card on last page.

communication and navigation equipment and direct the studies in system engineering.

He has worked with the airlines company 20 years. In Denver since 1946, he supervised the development of telecommunication requirements, procedures and policy involving air navigation and traffic control.

Donner Scientific Plans Expansion

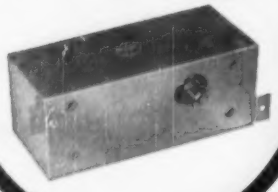
DONNER SCIENTIFIC COMPANY plans to build a new plant on a 10 acre site it recently purchased in Concord, Calif. The new 22,000 sq ft plant, scheduled for completion in June, will house the company's engineering laboratories, manufacturing facilities and administrative offices, now headquartered in Berkeley, Calif.

The first building will cost $125,000 and an additional $125,000 will be invested in machinery, equipment and fixtures. The setting will be arranged to permit expansion to 100,000 sq ft of floor space when required. Donner manufactures electronic test equipment, general purpose analog computers and aircraft control systems for inertial guidance of missiles and stabilization of aircraft.

The company was organized in August 1953 by W. K. Rosenberry, president, who also founded Berkeley Scientific Co. in 1946 and which was merged with Beckman Instruments in 1952. Under Rosenberry, Berkeley Scientific grew from a one-man operation, with an initial investment of less than $10,000, into an instrument firm with annual sales of $2,000,000 and 300 employees. Donner Scientific has increased its personnel 50% during the past 4 months and expects to be employing 500 persons by the end of 1957.

Donner also announced that Robert E. Krueger has been named marketing manager of the company.

Before joining Donner, Krueger was sales manager for Unitek Corp. in Pasadena, also before that chief mechanical engineer at Rutishauser Corp. in the same city. He was a staff member at Los Alamos Scientific Laboratory and



HYCOR
TELEMETERING
FILTERS

Hycor band-pass and low-pass telemetering filters are produced in exact accordance with accepted military standards. In addition to designs which conform to Applied Physics Laboratory specifications, miniature units are available.

Hycor telemetering filters are potted for complete protection against vibration and humidity. The finest components are used to minimize aging effects on characteristics.

Send for **Bulletin TF** *which describes standard types available.*

Hycor engineers will be pleased to quote on your most exacting specifications.

Representatives in Principal Cities

HYCOR

DIVISION OF
INTERNATIONAL RESISTANCE COMPANY

12970 Bradley Avenue, Sylmar 1, Calif.

Want more information? Use post card on last page.

VULCAN
ELECTRIC HEATING UNITS

Coils
of
Heat

Tubular Electric Heating Units that fit around or clamp to vessels, tanks, pipes, etc. for contact heating of metals, oils, air and water . . . . especially where little space is available and considerable heat is needed.

Can be bent into almost any shape.
STANDARD SIZES
or made to your requirements.

See 8-page Vulcan catalog in Sweet's Product Design File for 1958.

VULCAN
ELECTRIC COMPANY
DANVERS 10, MASS

MILFORD

TUBULAR RIVETS
SPLIT RIVETS
COLD-FORMED SPECIALTIES
RIVET-SETTING MACHINES

MILFORD
RIVET

THE
MILFORD
RIVET & MACHINE CO.

PLANTS: MILFORD, CONNECTICUT
HATBORO, PENNSYLVANIA • ELYRIA, OHIO
AURORA, ILLINOIS • NORWALK, CALIFORNIA

Want more information? Use post card on last page.

earlier was associated with Beckman Instruments and Douglas Aircraft in engineering capacities.

Thompson Products Names Gardiner

ROBERT A. GARDINER has joined Thompson Products of Cleveland to head research and development work of the company's electronics division in aircraft and missile controls, sub-systems and components.

He was formerly for 12 years with the Langley Aeronautical Laboratory of the National Advisory Committee for Aeronautics at Langley Field, Va. Earlier he was associated with Airborne Instrument Laboratories, of Mineola, N. Y. and General Industries Co. of Elyria, Ohio.

Stock Board Tours Packard-Bell Plant

ROBERT S. BELL, left, executive vice-president and Herbert A. Bell, right, of the Packard-Bell Co. team up to explain methods of mass producing television receivers to F. E. Naley, second from right, president of the board of governors of the Los Angeles Stock Exchange, during a tour of the firm's main plant by the group. Looking on is Dr. N. Jacoby, dean of the UCLA School of Business and a member of the board of Packard-Bell. Stock exchange members inspected the technical products division, color television research laboratory, cabi-

New high-vacuum pump

heats faster

cools faster

for faster cycling

CVC's KS-200 oil diffusion-ejector pump.

You can complete more process cycles an hour and cut maintenance costs with this new *CVC* oil diffusion-ejector pump.

The KS-200 is designed especially for TV tube aluminizing, vacuum-arc melting of metals, and other repetitive processes that require pressures in the 1 to 10 micron Hg range.

Faster heating. Four heaters (combined capacity, 2000 watts) heat the pump's fluid from a cold start to operating temperature in only seven minutes.

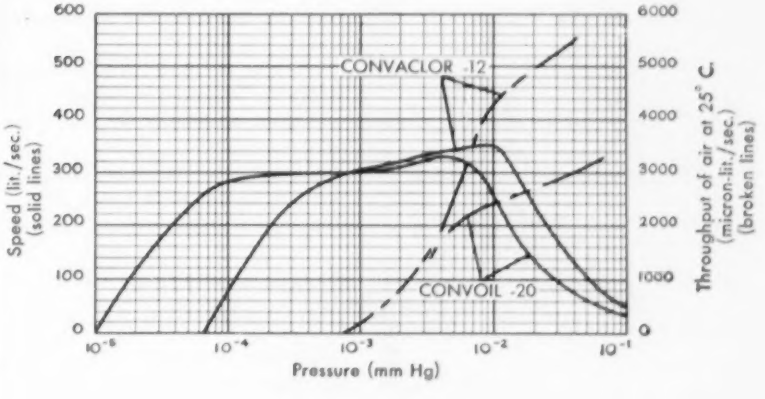
The heaters sit in cylindrical wells that jut up into the pump fluid from the bottom of the boiler—an arrangement that combines the low heat loss of an internal-immersion heater with the easy maintenance of a heater mounted externally.

Faster cooling. An internal coil in direct contact with the pump fluid cools it enough for safe exposure to atmosphere in only one minute, a saving of four to five minutes over old designs.

No valves needed. Convaclor-12 pump fluid gives you shorter warm-up and cool-down times with the KS-200. The saving offsets the longer cycling required by most high-vacuum pumps when used without valves.

With Convaclor-12 fluid the pump's ultimate pressure is 6 x 10^{-6}mm Hg. You can reach 1 x 10^{-5}mm Hg with Convoil-20 fluid, but speed and throughput become slower in the 1 to 10 micron range. See graph below.

The KS-200 costs $390 F.O.B. Rochester (price subject to change without notice). For full technical data, write for Bulletin 5-31.



CVC

Consolidated Vacuum

Rochester 3, N. Y.

a division of **CONSOLIDATED ELECTRODYNAMICS CORPORATION**, *Pasadena, California*

Sales Offices: Albuquerque • Atlanta • Boston • Buffalo • Chicago • Dallas • Detroit New York • Pasadena • Philadelphia • San Francisco • Seattle • Washington, D. C.

Want more information? Use post card on last page.

...high efficiency even at low plate voltages

PENTA

PL-6549

BEAM POWER PENTODE

This rugged, versatile power package, when used as a class C amplifier, delivers 60 watts at 600 volts... 110 watts at 1000 volts... with driving power **less than ¾ watt.** An efficient modulator, amplifier or oscillator. Provides distortion-free, high peak power for class AB, single sideband service. Beam pentode construction offers a combination of peak power and linearity unattainable with conventional tetrodes. Rugged—ideal for all mobile applications.

ratings

Filament—Thoriated Tungsten	(quick heating)
Voltage	6.0 volts
Current	3.5 amps
Plate Voltage, Max.	2000 volts
Plate Current, Max.	150 ma.
Screen Voltage, Max.	600 volts
Plate Dissipation, Max.	75 watts

PENTA offers a complete line of power diodes, triodes, tetrodes, pentodes for many a-f and r-f applications, hydrogen thyratrons and vacuum relays. For power tube information, write for data file 203.

PENTA *laboratories, inc.*

316 N. Nopal St., Santa Barbara, Calif.

Want more information? Use post card on last page.

net shop and production, testing and quality control sections of the Packard-Bell plant.

Mutual Electronics Firm Formed

A NEW company, Mutual Electronic Industries Corp. has been organized and will begin operations in a modern plant in New Rochelle, N. Y.

MEI will coordinate the manufacturing and licensing activities of Universal Aviation Corp., Essex Connector Corp. and United Cable Corp. It will also operate a research and development department for the design, evaluation and engineering of new and improved components in the electronic and allied fields.

The operations of MEI will be conducted, under R. W. McKirdy, president, by vice-presidents A. S. True, research and development; J. W. Schmidt, production, and James L. Risk, sales. B. B. McAlpin, partner of Laird & Co., is chairman of the board and Bradford S. Magill, an attorney and partner of Naylon, Foster, Dean, Shepard & Aronson, is secretary and treasurer.

M.I.T. Appoints Claude Shannon

DR. CLAUDE E. SHANNON, research mathematician at the Bell Telephone Laboratories in Murray Hill, N. J., has been appointed visiting professor of electrical communications at M.I.T.

While at M.I.T. during the spring term, Dr. Shannon will continue as an active member of the Bell Laboratories staff.

He will also be associated with the M.I.T. Research Laboratory of Electronics.

Computer Firm Elects Officers

COMPUTER CONTROL CO. of Wellesley, Mass., designers and manufacturers of digital computing and control equipment, announced a new slate of officers. Robert W. Brooks has been promoted from vice-president to president. Franklin R. Dean is vice-president in

ACME ISONEL WIRE

***Plus* Acme #150 VARNISH**
***Equals* Class B**
***Equals* MIL-T-27A Class S**

Freed Transformer Co., Inc., Brooklyn, N. Y., a leader in engineering and manufacturing of transformers and reactors for the electronics industry, has found in the above equation the solution to the manufacturing and performance problems of Class B (MIL-T-27A, Class S) Commercial and Military units.

Acme Isonel Wire is a Class B (MIL-T-27A Class S) wire. However, optimum insulation system performance can only be achieved when this wire is impregnated with a compatible varnish. Acme #150 is that varnish.

Acme #150 Varnish does not require a high temperature cure. It has excellent resistance to oils.

Acme #150 Varnish meets all the requirements of specifications MIL-V-1137A, Class CB, Type M for government equipment. In fact, it exceeds the heat resistance requirements of this specification by 50%.

Acme #150 Varnish improves thermal stability, while maintaining dielectric strength when used in Class B (MIL-T-27A Class S) windings.

FOR OUR COMPLETE PRODUCT LINE... electronics '55 BUYERS' GUIDE

ACME WIRE CO.

NEW HAVEN, CONN.

MAGNET WIRE • COILS
VARNISHED INSULATIONS
INSULATING VARNISHES
AND COMPOUNDS

Want more information? Use post card on last page.

charge of east coast operations and chief engineer. Kenneth M. Rehler is vice-president in charge of west coast operations. Other officers are Robert L. Massard, treasurer and William P. Horton, clerk of the corporation.

Brooks was one of the original founders of the company in 1952. Prior to the forming of CCC, he was in the computer department of Raytheon. He served as overall systems coordinator during the construction of the RAYDAC computer. He was also project engineer at Barber-Colman Co.

IBM Maps Western Expansion

IBM PLANS a multimillion dollar expansion of its west coast operations. The program includes:

A new 13-story office building and data processing center of advanced design in Los Angeles. Construction will start in mid-1956 and occupation by 600 people will get underway in mid-1957.

A six-story office building now nearing completion in San Francisco. Occupation by nearly 300 people will begin later this month.

New manufacturing, engineering and education facilities at San Jose. Approximately 400,000 sq ft will be built during 1956 and occupied by 1,500 employees beginning in the fall.

A new office building in Santa Monica. Over 150 people moved into this two-story structure in mid-January.

Data processing centers in Portland and Seattle. These facilities will be installed in Portland in March, in Seattle in June.

Byron Jackson Builds New Plant

THE Byron Jackson division of Borg Warner Corp. has begun construction on a 65,000 sq ft electronics plant in Santa Ana, Calif. Total cost of the project for property, buildings and equipment will be $1 million.

Construction, to be completed in June, will include a 45,000 sq ft

NOW YOU CAN AVOID THE MAKESHIFT NECESSITY OF USING PREMIUM CULLS FROM MIXER DIODES FOR VIDEO DETECTION.

New MA408 and 408A video detector diodes are specifically designed for high performance replacement of older 1N23B and 1N23C crystals!

★ Vastly improved sensitivity. The MA 408 insures a consistent minimum improvement in sensitivity in excess of 2 db over the older 1N23C.

★ When operated in the MA 611 X-Band crystal mount which is specifically designed and "mated" to the 408 diodes, a minimum figure of merit at 9000 mc is 160.

★ Users report up to 6 db improvement in signal-to-noise ratio.

★ Minimum theoretical tangential sensitivity of the new 408 crystal is −50 dbm, and for the extra sensitive 408A, it is −51 dbm for a receiver bandwidth of 10 mc/s.

★ Excellent broad band performance is exhibited in video applications from 1000 through 12,400 mc in terms of optimum signal-to-noise ratio and accurate reproduction of short pulses.

Send for prices and specifications. Units are available NOW in production quantities.

The MA 611 X-Band Crystal Holder is designated to the MA408 diodes to insure maximum performance.

GET THIS MICROWAVE CATALOG

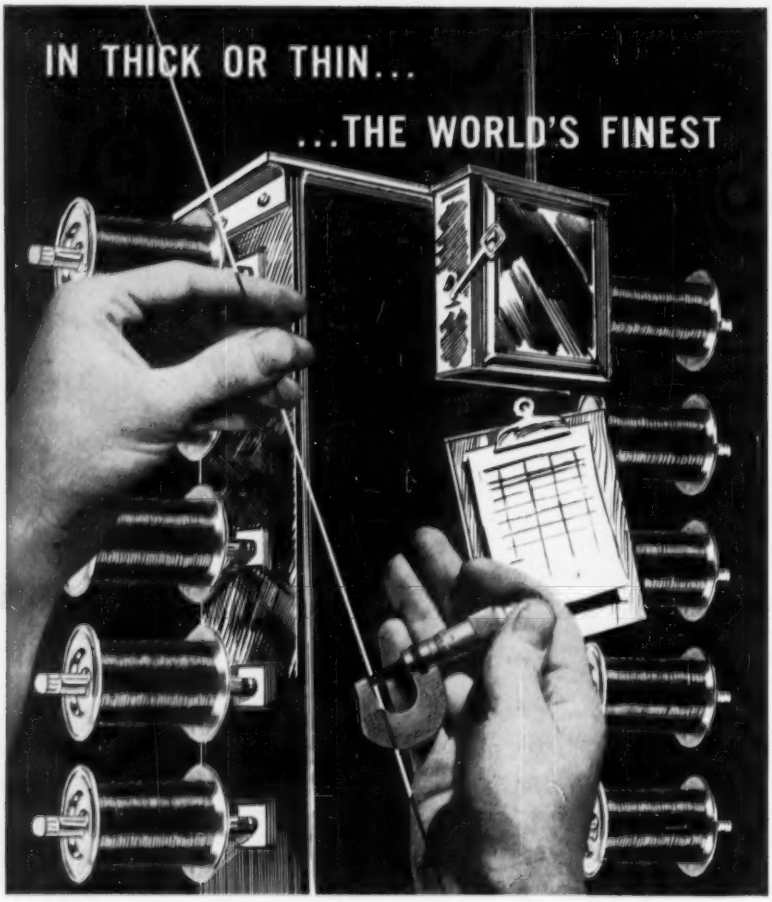
For problems involving microwave design and equipment you will find Microwave Associates catalog a basic reference.

Silicon Diodes · Magnetrons · Waveguide Components

MICROWAVE Associates INCORPORATED

22 Cummington St., Boston 15, Mass. CO 7-7577

Want more information? Use post card on last page.



TEFLON* INSULATED WIRE AND CABLE

The name Hitemp Wires, Inc. on a spool of Teflon insulated wire, tubing, multi-conductor cable, lacing cord or tape . . . is your assurance of highest quality — born of years of experience and development, and modern craftsmanship.

Although Teflon is as thin or thinner than ordinary insulations it has the amazing working temperature range of —90 C. to +250 C. . . . it has opened new horizons in the electrical and electronic industries.

Hitemp's Teflon insulated products offer: low loss factor, low dielectric constant, high volume resistivity, non-flammable, low coefficient of friction, unaffected by moisture, tough . . . yet flexible, completely inert to all known commercial solvents.

For better products . . . for lower production costs . . . for improved performance, call the leading specialist in high temperature insulations today . . . your nearest Hitemp Wires, Inc. representative or sales engineer.

HITEMP WIRES, INC.
26 WINDSOR AVE., MINEOLA, NEW YORK

NATIONAL REPRESENTATIVES

WASHINGTON, D.C. GOVERNMENT
John W. Houston Jr.
1625 "K" Street, N.W.
Washington 6, D.C.

N. Y. & N. J.
Par Distributors
240 Old Country Rd.
Hicksville, N. Y.

CANADA, VIRGINIA, W. VIRGINIA, PENNSYLVANIA
Aironic Accessory Co.
161 Orinoco Drive
Brightwaters, N. Y.

KENTUCKY & OHIO
Gallagher Company
15 Ritchie Ave.
Cincinnati, Ohio

TEXAS
General Power Equip.
5626 Dyer Street
Dallas 6, Texas

N. C., S. C., & TENN.
Glenn & Larson
123 Brevard Court
Charlotte 1, N. C.

MD. & DEL.
Sol. W. Goodman
32 W. Biddle St.
Baltimore 1, Md.

MICHIGAN
James B. Morrow
85 Louise Ave.
Highland Park, Mich.

INDIANA
Richard C. Warner
Box 338
South Whitley, Ind.

ILL. & WIS.
Wesley L. Wilson
2750 W. North Ave.
Chicago, Ill.

FLORIDA
Larry Johnson
8163 N. E. 2nd Ave.
Miami, Florida

ARK., KAN., MO., NEB.
White Supply Co.
4343 Duncan Ave.
St. Louis, Mo.

NEW ENGLAND
Richard Whitehead
Guilford, Conn.

IOWA
Caine Sales Agency
3020 N. Cicero Ave.
Chicago 41, Ill.

SAN FRANCISCO
Bill Kolans & Co.
3589 20th Street
San Francisco, Cal.

LOS ANGELES AND CENTRAL CALIF.
C. B. Rush
& Associates
3757 Wilshire Blvd.
Los Angeles 5, Calif.

S. CALIF. & ARIZ.
Fred W. Falck Co.
110 W. Broadway,
Rm. 404
Glendale 4, Calif.

UPPER N. Y. STATE
Philip L. Kirsh
223 Windemere Road
Rochester 10, N. Y.

EXPORT
Hitemp Wires, Inc.
Export Division
Mineola, N. Y.

OREGON & WASH.
Ray Johnston Co.
11009 Evanston Ave.
Seattle, Wash.

TULSA, OKLA.
Joseph Turner
P. O. Box 7068
Tulsa, Okla.

BIRMINGHAM, ALA.
C. W. Emory
P. O. Box 9013
Birmingham 9, Ala.

*DuPont's Trade Name for POLYTETRAFLUOROETHYLENE

building to house the main plant and offices, and a 20,000 sq ft testing laboratory. The main plant will eventually be enlarged to 100,000 sq ft.

The new facilities will consolidate Byron Jackson's electronic facilities currently handled in four separate plants in Pasadena, Calif.

Linear Equipment Changes Name

THE corporate name of Linear Equipment Laboratories of Copiague, New York, has been changed to LEL Inc. This was brought about by the sale of the Linear Instruments division to the Measurements Corp. of Boonton, N. J., subsidiary of Thomas A. Edison. Linear Instruments will move to Boonton. The sale included all instruments, trade marks, good will and the trade name "Linear." The Linear line of instruments will be marketed through the present Linear sales representatives retained by the Measurements Corp. LEL will devote its entire efforts to the i-f amplifier division. It will manufacture i-f strips and transistorized products.

Construction has been started on a new building adjacent to the present manufacturing plant which will double manufacturing area.

Harry R. Clark was elected president of LEL Sales Corp. of Copiague, New York. He will also continue as vice-president and general sales manager of LEL Inc. LEL Sales Corp. will market the firm's wrist radio on a national basis.

Nebraska Electronics Firm Established

J. J. JENSEN has been appointed general manager of Nebraska Electronics Manufacturing Co.

Nebraska Electronics is a new corporation formed jointly by Good-All Electric Mfg. Co. and Radio Industries, Inc., for the manufacture of ceramic disc capacitors. The company's plant is located in Ogallala, Nebraska. All sales will be handled by the distri-

bution organization of Good-All Electric.

Jensen had previously served as an assistant to the president of Good-All on staff assignments.

Penn-Texas Division Gets New Name

THE PLASTIC division, Colt's Manufacturing Co. of Hartford, Conn., a subsidiary of Penn-Texas Corp. of New York, N. Y., has changed its name to Manufactured Products Corp. The firm is a custom molder of plastics for packaging and industrial uses.

Two Engineers Join Bomac

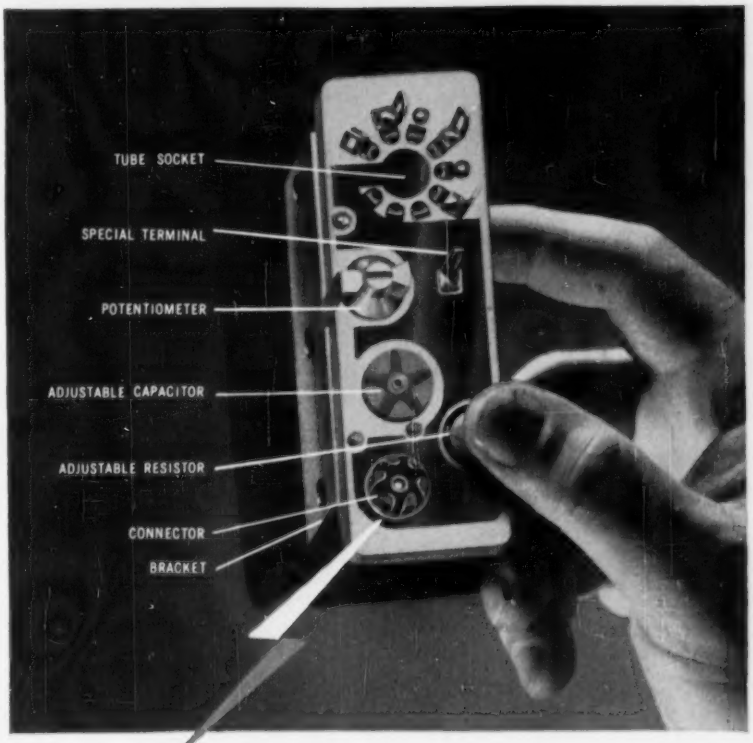
Louis W. Roberts

LOUIS W. ROBERTS joined the staff of Bomac Laboratories in Beverly, Mass. He will be in charge of a newly formed theoretical section which will function as a consulting group to other sections of the engineering department.

He comes to Bomac from Microwave Associates, where he was one of the founders and director of research. His background also includes consulting work for M.I.T. engineering manager for Sylvania and professor of physics.

Donald R. Lester joined the staff of Bomac as an electronic engineer. He will be in charge of klystron development.

He has been associated with Raytheon and Trans-Sonics, Inc., where



Look what YOU can have in Centralab

Packaged Electronic Circuits

Transitor Hearing Aid Circuit (with tone switch)

Oscillator-Detector Network

Special Filter Circuit

Take a look at the many features that can be built in CRL's versatile Packaged Electronic Circuits. Pictured are some special assemblies that illustrate the use of . . .

- Fixed and adjustable resistors.
- Fixed and adjustable capacitors.
- Inductance.
- Specialized switches.
- Wiring.
- Built-in tube sockets.
- Mounting brackets.
- Miscellaneous hardware.

Only Centralab P.E.C.* can accomplish such a variety. Over 160 standard P.E.C.* designs are available for your immediate use. For special requirements, call on Centralab engineers — but *early* in the planning stage, *before* you've "frozen" your design.

Remember this is not a laboratory curiosity. Over 55,000,000 are in use today.

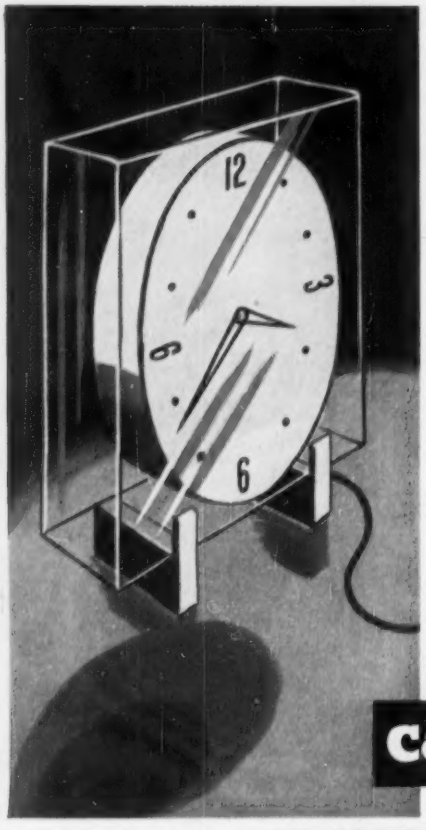
Write for technical bulletin 42-227.

Centralab

*Trademark

A DIVISION OF GLOBE-UNION INC.

914D East Keefe Avenue • Milwaukee 1, Wisconsin
In Canada: 804 Mt. Pleasant Road, Toronto, Ontario



Your time and COTO-COIL

Coto-Coils provide long life and accuracy to some of today's most dependable electric clocks.

Save your valuable time by handing over your coil problems to a specialist—Coto-Coil. With nearly forty years of "know-how" plus the most modern shop practices we can quickly produce the exact coil you need in quantity.

Send details to

COTO-COIL CO., Inc.
65 Pavilion Avenue
Providence 5, Rhode Island

PRECISION
Coto Coils
WOUND

FOUR-CHANNEL CARRIER-TELEPHONE TERMINAL FOR RADIO LINKS

This is a miniaturized unit of advanced design which provides four voice channels on a frequency-division basis above a voice-frequency order-wire channel. Each of these five channels is provided with a 4-wire 2-wire termination and a voice-frequency ringing circuit for d-c or 20-cycle signals. Adjustable attenuators are provided in the 4-wire side of all channels, and a built-in test oscillator and meter permit complete line-up, maintenance and trouble-shooting checks to be made. Channel levels are from −9 to 0 dbm and line levels from −30 to 0 dbm. Channel width is 300 to 3500 cycles within 1 db.

This unit is only 5¼" high by 19" wide by 14" deep. It mounts on a standard rack and operates from 115 volts 50-60 cycles a.c.

RADIO ENGINEERING PRODUCTS
1080 UNIVERSITY ST., MONTREAL 3, CANADA
TELEPHONE
UNiversity 6-6887
CABLES
RADENPRO, MONTREAL

he was an electronics engineer. His experience has been mainly in the research and development of klystrons and magnetrons.

Hycor Appoints Engineering Head

PHILIP R. GEFFE has been appointed engineering director of Hycor Co. of North Hollywood, Calif. He was chief filter engineer at Triad Transformer Corp. for three years, and joined Hycor last year as director of research.

American Instrument Names Chief Engineer

JAMES M. KLAASSE has been appointed chief engineer of American Instrument Co. of Silver Spring, Md., manufacturers of scientic laboratory apparatus. He was with W. & L. E. Gurley of Troy, N. Y. as sales manager of the industrial division and as chief engineer.

He was formerly chief seismologist of Beers & Heroy, consulting geophysicists of Dallas, Texas and Troy, N. Y., supervising physicist with the U. S. Naval Ordnance Laboratory and supervisory electronic scientist, Office for Atomic Energy, Headquarters, U. S. Air Force.

Vactron Builds Plant In Texas

VACTRON CORP. is building a 15,000 sq ft plant in Mansfield, Texas to house its office, factory, laboratory and warehouse facilities. The plant will remanufacture television picture tubes. Production of other electronic devices is planned.

Don Houghton and Silas A. Mayfield are president and vice-president, respectively of the firm. Ken E. Westenhaver is secretary-treasurer.

Siegler Buys Hufford Electronics

THE SIEGLER CORP. of Chicago and Long Beach, Calif., manufacturer of space heating equipment and electronic devices, has purchased for cash the assets of Hufford Electronics Company of West Los

Angeles, Calif. Hufford has contracts on hand for production of guided missile components which will be administered by Siegler's Hallamore electronics division in Long Beach, Cal.

Siegler acquired the business of the Hallamore Electronics Co. last year.

Axel Expands Electronics Division

AXEL BROTHERS electronics division moved to a recently purchased five-story plant in Jamaica, N. Y., the former Fairchild Camera & Instrument Corp. plant.

Axel also expanded and re-organized its design and development engineering staff, under the direction of Manuel L. Matnick, chief electrical engineer. The enlarged staff will concentrate on the design and development of electronic components

Du Mont Consolidates, Promotes Executives

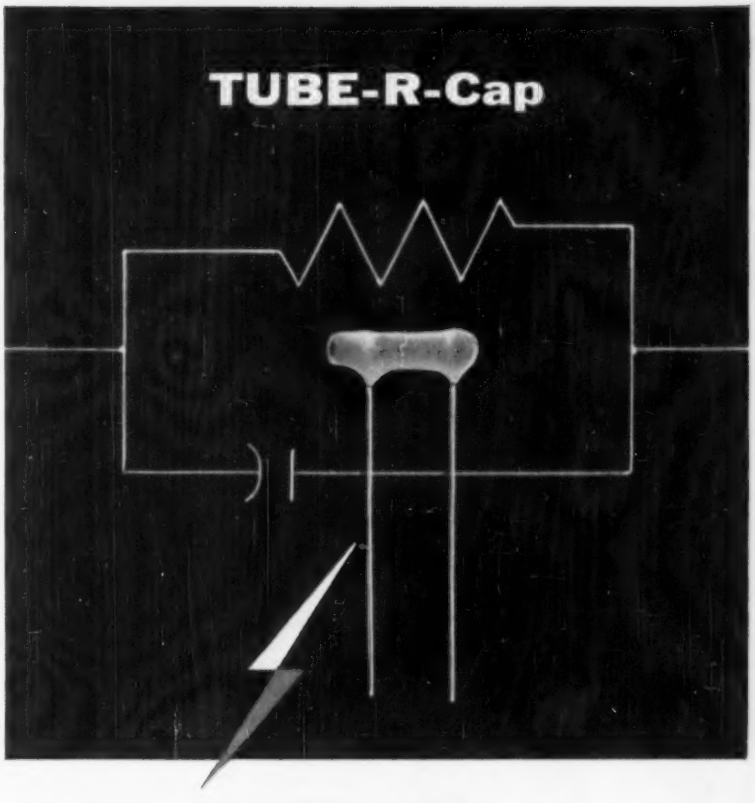
DU MONT LABORATORIES has consolidated all government manufacturing, engineering and sales operations into one division under Thomas T. Goldsmith, Jr., as vice-president and general manager of the government and research divisions.

Dr. Goldsmith has been head of Du Mont's research division since 1936. He will continue to direct the company's research division which also engages in extensive commercial programs and electronic applications.

Dr. Goldsmith joined Du Mont in 1936 as director of research, and he has been vice-president, research, since 1953.

Irving G. Rosenberg was appointed vice-president and general manager of the technical products division which embraces electronic instrument, broadcasting equipment and mobile communications operations. He has been with the company since 1942, and has served in various management capacities. He has been a vice-president since 1953.

William H. Kelley has been elected a director of the company



New RC Antenna Coupling Network

built to U/L specifications

Resistance ½ meg. nominal.

Capacity 470 mmf, GMV tol.

Tested at 1500 V.A.C., in accordance with U/L requirements.

Maximum size .312" diameter, .900" length.

Centralab Tubular Resistor-Capacitor Combination

There's nothing else like it!

Combines a high-quality, ceramic capacitor and a built-in fixed resistor in the space of a capacitor alone.

Costs you less than an equivalent combination of individual resistor and capacitor (not to mention installation cost)

Radial lead construction; Durez coated; stamped with capacity and resistance value.

Sets using TUBE-R-Cap *have been approved* by Underwriters' Laboratories.

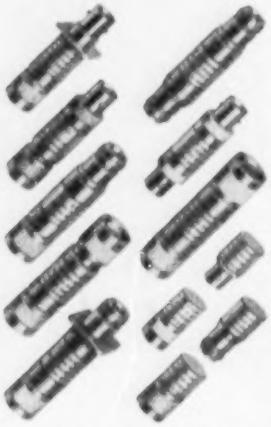
Write for Technical Bulletin EP-76.

Centralab A DIVISION OF GLOBE-UNION INC.

914D East Keefe Avenue • Milwaukee 1, Wisconsin
In Canada: 804 Mt. Pleasant Road, Toronto, Ontario

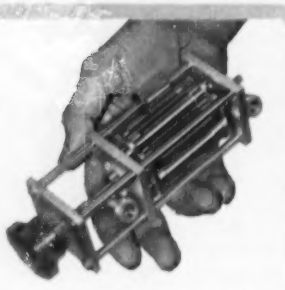
PRECISION ATTENUATION to 3000 mc!

SINGLE *"in-the-line"* **ATTENUATOR PADS** *and* **50 ohm COAXIAL TERMINATIONS**



PROTECTED UNDER STODDART PATENTS

This new group of pads and terminations features the popular Types C and N connectors, and permits any conceivable combination of the two styles.



PROTECTED UNDER STODDART PATENTS

six-position

TURRET ATTENUATOR

- **Frequency Range:** dc to 3000 mc.
- **Characteristic Impedance:** 50 ohms.
- **Available Attenuation:** Any value from 1 db to 60 db.
- **Accuracy:** ±0.5 db.
- **Power Rating:** One watt sine wave power dissipation.

STODDART
Aircraft Radio Co., Inc.
6644-A SANTA MONICA BLVD.
HOLLYWOOD 38, CALIF. • HO 4-9294

Want more information? Use post card on last page.

and vice-president and general manager of consumer products.

He joined Du Mont in 1954 as vice-president, marketing. As a director, he succeeds Stanley F. Patten who just recently assumed the office of treasurer, and now holds the dual office of vice-president and treasurer.

Kelley will direct the operations of the firm's receiver division and the cathode-ray tube division.

Arthur Israel, Jr., was elected secretary and Bert L. Graham as assistant secretary.

Israel has been assistant secretary. He succeeds Bernard Goodwin, who has resigned.

Graham was formerly controller, then special assistant to the president before succeeding Israel as assistant secretary.

Philips Selects Research Head

John A. Hipple

JOHN A. HIPPLE has been elected vice-president and director of research of North American Philips Co. He will succeed O. S. Duffendack as director of the Philips laboratories at Irvington-on-Hudson.

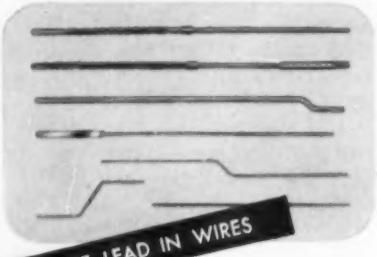
Dr. Duffendack, who has reached retirement age, will continue for this year as a member of the board of directors and as a consultant.

Since 1953, Dr. Hipple has been director of the Mineral Industries Experiment Station and assistant dean of the College of Mineral Industries at Pennsylvania State University. He was chief of the atomic

Specify **DKE** *for—*

PRECISION QUALITY components

OF TUNGSTEN, MOLY, NICKEL CLAD WIRE, ALLOYS, KOVAR



• DKE LEAD IN WIRES

Quality controlled throughout production with Tungsten hard glass leads produced under General Electric Timing Control. Each tungsten lead is microspecially inspected for flaws. DKE offers highest quality and LOW PRICES. Send drawings for quotations and let us prove the economy of our prices.

• DKE TUBE BASES

The Engineering Company can give you immediate delivery on following bases: 50 Watt, 3303B, 412 Industrial Base, Giant 7 Pin Bayonet, 4310 Four Pin Jumbo, Tetrode, Hydrogen Thyratron Bases in both Aluminum and Copper up to 6.50 dia. etc. All bases to JAN-1A/MIL-E-1B and subjected to weights and strength tests.

DKE HYDROGEN THYRATRON TUBE BASES

CALL OR WRITE FOR QUOTATIONS ON YOUR SPECIFIC REQUIREMENTS

THE engineering CO.

27 WRIGHT ST., NEWARK 5, N.J.

Want more information? Use post card on last page.

physics section of the National Bureau of Standards from 1947 to 1953.

Association Elects New Officers

ELECTRONICS MANUFACTURERS ASSOCIATION elected the following officers: president, I. A. Mitchell of United Transformer Co.; treasurer, Hyman Winograd of Presto Recording Corp.; secretary, Allan C. Bernstein of Adams Laboratories.

Elected to the board of directors were David Wald of Dewald Radio Mfg. Co. and United Scientific Laboratories; I. Walter Wyckoff of Pilot Radio Corp.; Lloyd Hammarlund of Hammarlund Mfg. Co. and Arthur Blumenfeld of University Loudspeakers.

Texas Instruments To Acquire Burlington

TEXAS INSTRUMENTS plans to purchase the business and assets of the Burlington Instrument Co. in a cash transaction.

Burlington Instrument, 20-year-old manufacturer of electrical indicating instruments, is located in Burlington, Iowa. The entire operation will be integrated with the TI components division and transferred to Dallas as soon as possible. Manufacturing space has been leased near the firm's main Dallas plant for the expansion of the components division.

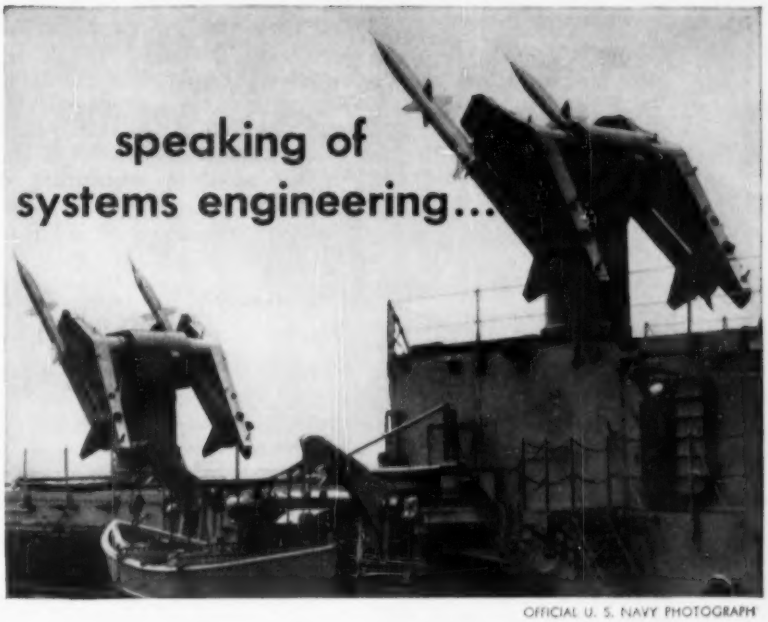
Burlington product sales have totalled well over a million dollars per year.

Varian Associates Name Patterson

HOWARD R. PATTERSON, formerly vice-president and general manager of Chromatic Television Laboratories of Oakland, Calif. has joined Varian Associates as manager of the production engineering department.

The former department head, B. C. Gardner, has been promoted to head the product engineering division.

Patterson served as chief engineer of the television and pick-up tube factories of RCA at



OFFICIAL U. S. NAVY PHOTOGRAPH

THE USS Boston, recently commissioned as the first guided missiles warship in history, carries the newest and most powerful weapons afloat.

Vitro Laboratories takes pride in the Navy's "well done" for its part in the systems engineering of the missiles installation and launching system on the Boston.

Another first in the important new field of systems engineering is the comprehensive multiple-range timing system conceived, developed, installed and operated by Vitro for armament testing at the Air Force Armament Center in Florida. By means of pulse electronics, a time signal generator establishes base "central" time measured in 10,000ths of a second. The system transmits time signals to remote ground and airborne stations for precision command timing and time identification of action photographs.

These are but two of many examples of Vitro's role in systems engineering of the most advanced kind. They are forerunners of significant new systems applicable across a broad industrial spectrum.

Vitro Laboratories is now building a million-dollar laboratory to make its staff and facilities available for new industrial and governmental projects.

Write for detailed information to

VITRO LABORATORIES, 962 Wayne Avenue, Silver Spring, Md.

A Division of

Vitro CORPORATION of AMERICA

261 Madison Ave., New York 16, N.Y.

Research, development, weapons systems
Nuclear and process engineering, design
Refinery engineering, design, construction
Uranium mining, milling, processing, refining
Rare metals, heavy minerals, fine chemicals
Ceramic colors, pigments, chemical products

Want more information? Use post card on last page.

CODE MARK Anything! WITH

★ CODE MARKING INKS

For Resistors and Capacitors. For Machine or Hand Application.

Whatever the substance, Phillips has an ink to mark it permanently and legibly—or can make one. Marking experts insist on "Clear Print" Wood Block Stamp Pads and Opaque Inks. They get clear, sharp, fast-drying impressions. Also inks for brush, pen, stencil or machine application available in a variety of colors and quantity containers.

★ Quick Laboratory Service On Your Problem Markings.

★ To Permanently Mark . . . Metals, Plastics, Glass, Wood, Paper, Leather, Ceramics—glazed, varnished or lacquered surfaces and virtually every other known material.

WRITE FOR FREE BOOKLET

L. A. PHILLIPS, President

PHILLIPS PROCESS CO. INC.

192 MILL STREET

ROCHESTER 14, N. Y.

Want more information? Use post card on last page.

Lancaster, Pa., as chief production engineer in the Chicago cathode-ray tube factory of Rauland Corp. and as chief engineer of the cathode-ray tube department of Raytheon before joining Chromatic in 1951.

Daystrom Realigns Three Executives

SAMUEL J. CHILDS has been appointed vice-president and general manager of Weston Electrical Instrument Corp., a subsidiary of Daystrom, Inc. Childs, who was formerly president of Daystrom furniture division, will be in charge of all manufacturing and production at Weston.

He was president and treasurer of the Friend Manufacturing Co. in Gasport, N. Y. and of the Bennett Manufacturing Co. in Alden, N. Y. before joining Daystrom.

George J. Parker was appointed vice-president of Daystrom in charge of its Washington office. He was formerly president of the Daystrom Instrument division at Archbald, Pa. Walter W. Slocum, recently promoted to vice-president of operations of Daystrom, will assume current responsibility for the operation of the instrument division.

Air Associates Appoints Harries

Wolfgang Harries

WOLFGANG HARRIES has joined the staff of the research and development division of Air Associates.

Dr. Harries came to the United

Another PRESTO precision instrument

Model 100

M · S · F · S*

The Presto Model 100 *Microwave Secondary Frequency Standard is a versatile, inexpensive test signal generator. In the laboratory or on production test bench, the Model 100 together with microwave receiver and auxiliary signal generator, will provide rapid measurement of frequencies from 50 to 11,000 mc, with ±.005% accuracy.

The Presto Model 100 will

- perform functions of expensive primary standards
- calibrate standard signal generators
- establish standard frequencies
- calibrate and align receivers
- test radar or microwave installations
- provide markers for panoramic displays

This unique and valuable instrument weighs only 8½ pounds and comes complete with 4 foot RG-58/U cable with UG-260/U connectors, Presto XH microwave crystal holder with Type N male plug and 8 foot power cable.

Price: $265.00 f.o.b. Paramus, N. J.

Write for complete information and specifications.

PRESTO

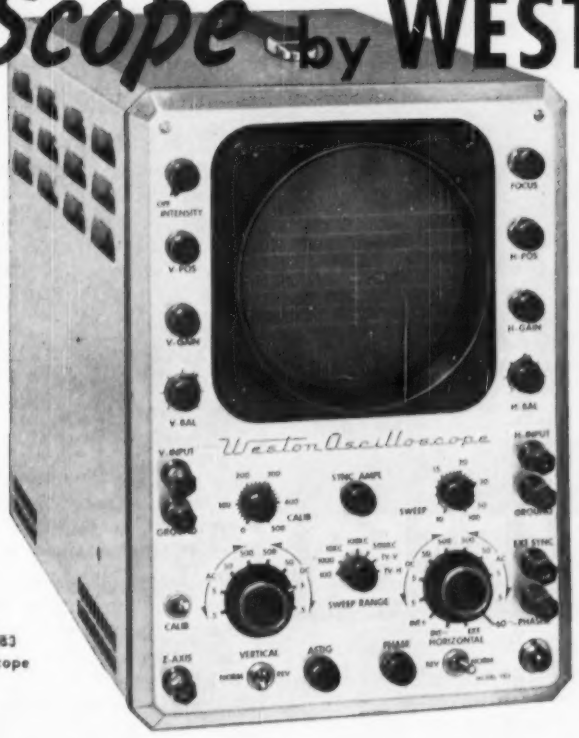
RECORDING CORPORATION

Specialty Products Division

Paramus, New Jersey

Want more information? Use post card on last page.

NOW...the All-purpose 'Scope by WESTON



Weston
Model 983
Oscilloscope

Model 983 is a high gain, wideband Oscilloscope designed to accurately reproduce waveforms comprising a wide band of frequencies. High sensitivity of 15 millivolts per inch RMS makes this "scope ideal for—SETTING RESONANT TRAPS... SIGNAL TRACING IN LOW LEVEL STAGES... AS A GENERAL NULL INDICATOR... for PHASE CHARACTERISTIC MEASUREMENT IN INDUSTRIAL APPLICATIONS...and for SWEEP FREQUENCY VISUAL ANALYSIS.

The 'scope contains identical vertical and horizontal push-pull amplifiers with a choice of AC or DC coupling without affecting either sensitivity or band width. Both amplifiers have compensated step attenuators and cathode follower input. *It has excellent square wave reproduction with overshoot of only 2 to 5%, with a rise time of 0.1 microsecond. The 'scope response is essentially flat throughout the specified range of 4.5 mc and is usable to 6 mc.*

The unit has provisions for internal calibration, internal phased sine wave, and Z-axis intensity modulation. Reversal of polarity of both horizontal and vertical signals is easily accomplished by means of toggle switching. *Tube replacements are non critical, and etched circuitry facilitates quick and rapid maintenance.*

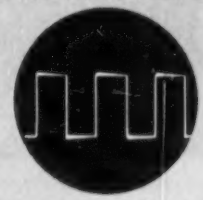
The Model 983 Oscilloscope is now available through local distributors. For complete literature write WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON *Instruments*

WAVEFORM ANALYSIS

Response curves accurately displayed. Ideal for use with Weston intensity marker display. A fast, retrace sweep circuit with cathode follower output prevents pattern distortion.

SQUARE WAVE RESPONSE

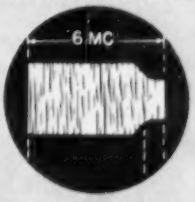


Overshoot is only 2 to 5%. Rise Time is 0.1 Microsecond. Square wave depicted 250 kc.

PHASE MEASUREMENTS

Phase shift between horizontal-vertical amplifiers, 0-500 kc-0°, to 1 mc within 2°; by internal adjustment with gain controls at max 0° phase shift possible on any specific frequency to 6 mc.

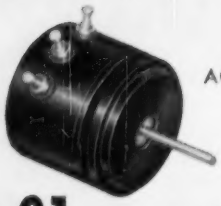
RESPONSE CHARACTERISTIC



Note flatness throughout specified range; to 3.6 mc down 1.5 db, at 4.5 mc down 3 db, at 6 mc down 6 db.

Want more information? Use post card on last page.

NEW *Jewel-bearing "LO-TORK"*



ACTUAL SIZE

0.01 ounce-inches

PRECISION *wire-wound* POTENTIOMETER

Jewel bearings for lowest torque, and superior seal against surroundings that contain abrasive dust, make this new, Model LLT ⅞ Waters pot the ideal unit for high-reliability service where minimum torque is essential. With torque low enough to permit actuation by a Bourdon tube or a bimetallic thermal element, this potentiometer offers new advantages in sensitive-instrument applications as well as in computer, servo, and selsyn uses. Check your needs with these specifications:

Maximum torque: .....0.01 ounce-inch
Dissipation: .....one watt at 80° Centigrade
Resistances: .....100 ohms to 100,000 ohms
Weight: .....½ ounce
Outside diameter: 0.885 inch **Body depth:** ⅞ inch
Linearity: 0.5% standard; on special order, 0.25%
Winding angle: 354° standard; on special order, 360°
Ganging: to six decks with no increase in diameter.

Where the features of a ball-bearing potentiometer are desirable, specify Waters Model LT ⅞ "Lo-Tork" potentiometer.

Write for data sheets on jewel-bearing and ball-bearing precision wire-wound potentiometers.

Do you ever need pots that are "just a bit different"? Maybe we can help you — by modifying a standard Waters design or by taking a bold, new approach. Tell us your need and we'll tell you what we can do.

WATERS MANUFACTURING, inc.
Wayland, Massachusetts
Mail address: P.O. Box 368, So. Sudbury, Mass.
APPLICATION ENGINEERING OFFICES IN PRINCIPAL CITIES

MFG. INC.

States from Germany in 1951. He was formerly chief engineer for Matawan Electronics Co., a subsidiary of Lavoi Laboratories, where he was responsible for the development of automatic calibrators and testors for electronic equipment.

CBS Names Quality Chief

DAVID S. BLACKWELL has been named manager of quality control for CBS-Columbia.

He was formerly chief production engineer for the Warwick Manufacturing Corp. and director of quality for Capehart-Farnsworth.

Kearfott Plans New Plant

KEARFOTT CO., GPE subsidiary, plans a new engineering-sales building to be constructed opposite the present home offices and production plants in Little Falls, N. J.

The target date for completion of the building is early 1957.

Kearfott's present engineering forces will provide the majority of the 1,500 persons expected to be employed in the new building. More than 500 additional engineers, technicians and production specialists are being added.

The new building, which will contain 240,000 sq ft of floor space, will increase the total facilities of Kearfott to 600,000 sq ft.

Hughes Aircraft Appoints Two Engineers

HUGHES AIRCRAFT CO. appointed J. W. Clark and S. W. Lichtman to the scientific staff of its research and development laboratories.

A specialist in high power microwaves and nuclear electronics, Dr. Clark will serve as a staff scientist reporting directly to Dr. A. V. Haeff, vice-president and director of research.

Lichtman, associated with guided missile and rocket research, heads the missile reliability effort of the Hughes systems engineering department.

Dr. Clark was most recently with Litton Industries where he was

HIGH-μ FERRITE POT CORES FOR EFFICIENT MINIATURIZATION

Versatile Ferroxcube pot cores permit construction of miniature coil assemblies having moderate inductance values with relatively high Q. Shielding is excellent, stray fields are minimized. Cores can be placed close together or even stacked, with negligible coupling between adjacent coils.

Ferroxcube Pot Cores are available in 3 high permeability ferrite formulations.

WRITE FOR ENGINEERING BULLETIN

FERROXCUBE CORPORATION OF AMERICA

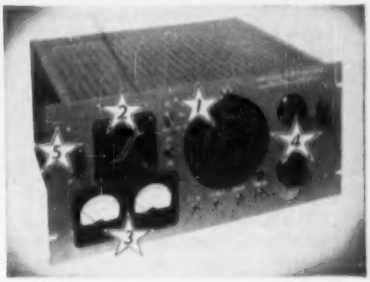
A Joint Affiliate of Sprague Electric Co. and Philips Industries
Managed by Sprague

35 EAST BRIDGE STREET • SAUGERTIES, NEW YORK

NEW! DOUBLE-RANGE Incremental-Inductance BRIDGE

For production and laboratory testing of coils with d-c and a-c magnetization.

This new, two-in-one instrument provides fast, easy measurement of inductance from zero to five and five to 180 henries, with superimposed d-c from one to 500 milliamperes, in inductors up to 750 ohms resistance. Accuracy ± 3%.



FEATURES

1. Direct reading of inductance on large, balance-control dial calibrated for 60 - 400 - 1000 cps, and for use at any intermediate frequency.
2. Three-inch 'scope shows phase-difference nulls.
3. Panel instruments read direct current and a-c volts.
4. Continuous and independently adjustable control of a-c voltage, 0-135 v., and direct current supply, 0-500 ma.
5. External-frequency input for measurements at frequencies between 60 and 1000 cycles.

The double-range calibration of the Model 1002-C Incremental Inductance Bridge permits high accuracy in the measurement of low values. Its rapid, simple operation and rugged construction make it equally suitable for production-line and laboratory use. For detailed information, write for bulletin EL-4.

Price $895.00 complete, net F.O.B. Wayland, Mass.

WATERS MANUFACTURING, inc.
MFG. INC.
Wayland, Massachusetts
Main address P.O. Box 368 So. Sudbury, Mass.
APPLICATION ENGINEERING OFFICES IN PRINCIPAL CITIES

STOCK KNOBS
IN ANY QUANTITY
NEVER A MOLD CHARGE

GEE-LAR—The House of Knobs—can give you a wide selection of knobs for every application. Hundreds of patterns and styles always in stock, and you're never concerned with a tool charge.

WRITE TODAY for illustrated GEE-LAR Catalog. Free!

GOLD INLAY KNOBS

Select your knobs or pointers from GEE-LAR'S huge stock of quality products. Fast service . . . lower cost—always at GEE-LAR!

GEE-LAR MANUFACTURING COMPANY
421 South Wyman Street • Rockford, Illinois

Want more information? Use post card on last page.

GUDEMAN

NEW MINIATURE FEED-THRU CAPACITORS

Paper Dielectric — Hermetically Sealed
Gudeman Impregnant #257
Types 271 and 272

The Gudeman Feed-Thru Capacitor, Types 271 and 272, is a three-terminal component designed to be used for R.F. Interference suppression in a manner similar to a low pass filter. The typical insertion loss characteristics for these Feed-Thru Capacitors when measured in a 50 ohm line are in accordance with MIL-Standard 220.

The internal construction of these Feed-Thru Capacitors is designed so as to minimize the inherent inductance; therefore, these units perform functionally as nearly as possible to an ideal capacitor.

NEW RADIO INTERFERENCE FILTERS

- Screw neck mounting
- Hermetically sealed tubular construction
- Glass compression or ceramic solder seal terminals
- High insertion loss from .15 to 1000 MC
- Ratings range from 1 to 20 amps at 125 V.A.C. (0-400 cycles) or 400 V.D.C.
- Operating temperature range: −55° C. to + 85° C.

THE GUDEMAN CO.
340 W. Huron, Chicago 10

Want more information? Use post card on last page.

director of the nuclear electronics division. Lichtman was head of the missile laboratory division of the Naval Ordnance Laboratory, Corona, Calif.

Astron Buys Skottie Electronics

ASTRON CORP. of East Newark, N. J., manufacturers of capacitors and r-f noise interference filters, bought all of the outstanding stock of Skottie Electronic Corp. of Peckville, Penna. The purchase includes the plant buildings and production facilities.

Skottie manufactures ceramic capacitors and also supplies subminiature units designed specifically for transistorized and printed circuits.

Steps are being taken to expand the firm's production facilities.

Eitel-McCullough Selects Hall & Heil

James L. Hall

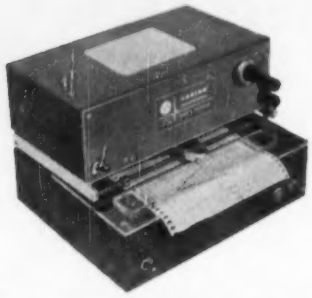
JAMES L. HALL has been named group leader of the ceramic receiving tube group for Eitel-McCullough of San Bruno, Calif., manufacturer of electron-power tubes.

Dr. Hall has assumed the duties of Paul Williams who has moved to the position of special assistant to the director of research. Hall came to Eimac as an electronic research engineer in July, 1953 from the Stanford Research Laboratory. He was made assistant department

have you ever seen a graphic recorder with . . .

- **PORTABILITY** . . . weighs less than 15 pounds, measures 10" x 7⅛" x 8".
- **VERSATILITY** . . . can be used as recording millivoltmeter or —with appropriate transducers — to record measurement of physical quantities.
- **RECTILINEAR** trace representation.
- **FULL CHART** zero positioning.
- **HIGH INPUT** impedance and high allowable signal source impedance.
- **PANEL** damping control for optimum stability.
- **CHART DRIVE** extension for synchronization with other equipment.

THE VARIAN G-10 GRAPHIC RECORDER HAS ALL THESE FEATURES AND MORE . . . IS PRICED AT $295



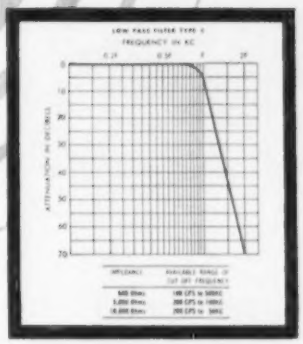
WRITE TODAY FOR COMPLETE TECHNICAL DATA ON THIS REMARKABLE NEW INSTRUMENT AND ITS FULL ACCESSORY LINE.

Special Products Division
VARIAN associates
PALO ALTO 5 CALIFORNIA

Representatives in all principal cities
MICROWAVE TUBES — INSTRUMENTS

Want more information? Use post card on last page.

Clarify all types of **Audio Frequencies**



Available in a wide variety of types, frequency characteristics and impedance matches.

Boehme Communication Filters
Especially designed . . .

- for minimum "ringing" or "tailing" (transient response)
- for optimum results under dynamic conditions

Write for data sheets, today!

H.O. Boehme, Inc.

Designers and Manufacturers Communication Equipment Since 1917
Precision Electro-Mechanical Apparatus
915 Broadway • New York 10, N.Y.

HOW FAR ARE YOU GOING AS AN

ELECTRONIC ENGINEER?

If you're a qualified electronic engineer with ability, ambition, and imagination, your best chance for professional growth is with Electronic Engineering Company of California.

You can exercise your initiative and versatility on the wide variety of projects that form our increasing backlog. And you will be assured of recognition, security, excellent facilities, and the finest possible working conditions.

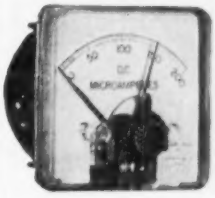
How far you go is up to you!

Send a resume of your background to Bob Lander

Electronic Engineering Company
of California
180 SOUTH ALVARADO STREET
LOS ANGELES 57, CALIFORNIA

METER-RELAYS

For Sensitive and Accurate Control



RANGES:
0/20 Ua. to 0/50 A.
0/5 Mv. to 0/500 V.

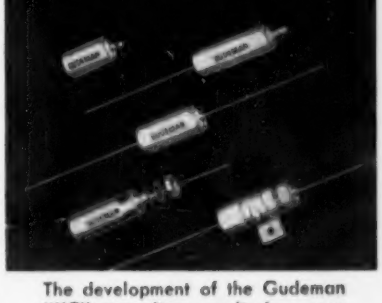
The trip point is adjustable to any point on the scale arc. These meter-relays are sensitive to changes of as little as 1%. One contact is carried on moving pointer. The other is on a semi-fixed pointer. When two pointers meet contacts close and lock. Holding coil is wound directly over moving coil. Reset can be manual or automatic. Spring action in contacts kicks them apart forcefully. Three sizes of clear plastic case models, 2½, 3¾ and 4½ inches (all rectangular). Two ruggedized and sealed models, 2½ and 3½ inches (round metal cases). Contact arrangements: High Limit Single, Low Limit Single or Double (both high and low). Contact rating is 5 to 25 milliamperes D.C.

Suggested circuits for meter-relays and complete specifications including prices are covered in new 16-page Bulletin G-6, which you can get by writing Assembly Products, Inc., Chesterland 4, Ohio.

GUDEMAN

NEW "XC" PLASTIC FILM DIELECTRIC CAPACITORS

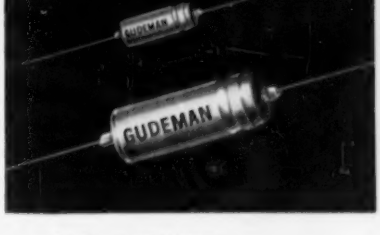
Hermetically Sealed (Glass to Metal) Tubular Cased



The development of the Gudeman "XC" capacitors results in a new line of high temperature capacitors that has exceptionally high insulation resistance, low power factor and low dielectric absorption. The case sizes were selected whereby no voltage derating is required when the capacitors are used within a temperature range from −65° C. to +165° C.

The Gudeman "XC" capacitors as shown are hermetically sealed, tubular, oil filled (Gudeman Impregnant #258), plastic film dielectric. Other case styles such as bathtub and rectangular types are available.

NEW MINIATURE DRY ELECTROLYTICS



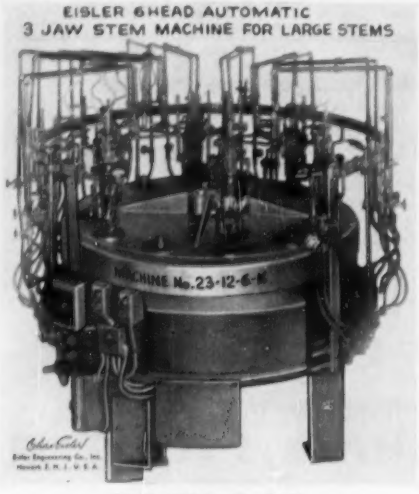
- Gudeman "EMM" Type
- Size Range 3/16" to ⅜" diameter ½" to 1" long
- Capacity Range: 1 MFD to 100 MFD
- Voltage Range: 3 V.D.C. to 50 V.D.C.
- Operating Temperature: 65°C.
- Hermetically Sealed
- 99.99% Purity Foil
- Low Leakage Current
- Low Equivalent Series Resistance

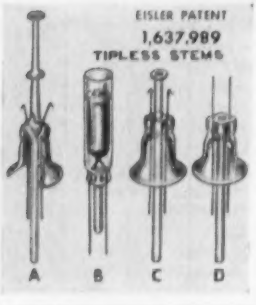
THE GUDEMAN CO.
340 W. Huron, Chicago 10

You Name It EISLER Makes it...

Eisler tipless stem patents have been extensively used by incandescent lamp and radio tube manufacturers. Eisler patents are free and have been a source of protection to the radio tube and lamp industry. Why not consider your next machine an Eisler? Serving the Industry over 35 years.

Send for Catalog





CHAS. EISLER, JR., PRES.

EISLER ENGINEERING CO., INC.

751 So. 13th St. NEWARK 3, N. J.

Reliance Mica Co., Inc.

MICA SPECIALTIES

RADIO and TV TUBE SPACERS

CAPACITOR FILMS

HEAT RESISTANCE WASHERS

Reliance are specialists in the fabrication of Mica parts. For 27 years, they have met industry's specifications for critical tolerance and quality control. Our years of experience meeting close tolerance work can help you whenever you are faced with tight specifications and our quality control will meet the increasing rigid specifications of today's design

QUALITY MICAS MAKE QUALITY TUBES

Is your application of Mica correct?
Consult us for help in obtaining the proper use of Mica in your products.

RELIANCE MICA CO., INC.
341-351 39th St. Brooklyn 32, N. Y.

head of the receiving tube group at Eimac in December, 1954.

Oskar Heil has joined the firm as group leader of the advanced research group recently formed in the research laboratory.

He comes from Wright Air Development Center at Wright Patterson Air Force Base, Ohio. He will direct research work on new types of tubes and theoretical study of electron beams.

Roger White Expands Plant

ROGER WHITE ELECTRON DEVICES of Ramsey, N. J. acquired a new plant in Haskell, N. J. The firm manufactures microwave equipment for both commercial and military uses.

The new plant triples previous facilities and will be devoted to the production of microwave equipment including traveling wave tubes, backward wave oscillators, gas control tubes and test equipment.

Heli-Coil Buys Towle And Son

HELI-COIL CORP. of Danbury, Conn., manufacturers of wire thread inserts, purchased the entire manufacturing facilities of the Towle and Son Co. of Conshohocken, Penna., precision manufacturers in the aircraft and electronic fields.

Heli-Coil will move all Towle equipment to Danbury and combine the facilities of both organizations, with Towle as a division of the Heli-Coil Corp.

Defiance Executives Acquire Interest

ANDREW A. CIROLIA and Percy E. Goodwin, executives and principals of Defiance Engineering & Microwave Corp. and Defiance Microwave Corp., have, individually, acquired an interest in and are now associated with Union Electronics & Machine Corp. of Georgetown, Mass. as president and treasurer, respectively. Union

Will this blot spread... or shrink?

NOTHING STRIKES so brutally at human lives as a slum.

Yet of America's many millions of homes, the blot that is a slum covers more than 1 out of every 10 . . . and nearly one-half of all our homes are urgently in need of repair and basic improvements.

Will the blot go on spreading? Or will a concerted, nationwide attack on the causes of slums shrink it, year by year, until it is wiped out? Today, this is a challenge to every American . . . a challenge that *must* be met.

Your community . . . your problem!

A slum reaches across blocks, across miles, to sit on your doorstep and demand a price.

You pay it in the threat of crime and juvenile delinquency to your family. You pay the price in higher personal property taxes to fight the disease and crime and poverty that are slum-bred. You pay personally when the value of your home sinks as community deterioration takes another step closer.

Your *firm* pays when the community where you do business goes downhill. Slums automatically mean lower purchasing power and less effective labor.

Good citizenship is good business

It's good citizenship and good business both for your firm to join efforts to check housing decay . . . to stop slums before they start. In fact, it's the *responsibility* of every business, as it is of every other good citizen, to support community improvement efforts.

Some slums are beyond repair. They should be torn down and a fresh start made. Others can be remodeled, made to conform to better living standards. So it is up to you to get behind every sound program which seeks to provide adequate housing for all our people.

Adding your support to the efforts of the millions already attacking the problem, your firm can help stop slums cold and put America's housing standards at a new height.

How to get into action

A group of Americans from every walk of life has formed a new, non-profit organization to help combat home and community deterioration – The American Council To Improve Our Neighborhoods . . . A.C.T.I.O.N.

Send for a free copy of "ACTION." It explains what A.C.T.I.O.N. is and proposes to do. It also lists booklets, research reports, check-lists, and other material which can help you protect the housing health of your community. Address P. O. Box 500, Radio City Station, New York 20, N. Y.

ACTION

American Council To Improve Our Neighborhoods

New!
COLOR
& BLACK & WHITE
LAB & TV SERVICE
5" SCOPE

5 MC BANDWIDTH
& DC AMPLIFIERS

- Flat from DC to 4.5 mc to reproduce 3.58 mc sync burst and oscillator signals in color TV sets.
- 4-step freq-compensated attenuator in both AC and DC positions.
- Built-in calibrator permits peak-to-peak voltage measurement.
- Automatically syncs anything visible on the screen.
- Pre-set TV V & H sweep positions (30 cps & 7875 cps).
- Edge-lit lucite engraved graph screen with dimmer control; filter; standard bezel fits standard photographic equipment.
- 5UP1 CRT

#460
Factory Wired $129.50
KIT $79.95

- V amplifier direct-coupled and push-pull thruout; gradual roll-off beyond 4.5 mc; useful at 10 mc.
- High V sensitivity: 25 mv/in.
- Choice of direct coupling (DC) or capacitive coupling (AC).

EICO®
Write for FREE New 1956 Catalog E-4 and Name of Distributor
84 Withers Street • Brooklyn 11, N. Y.
©56 Prices 5% Higher on West Coast
NOW IN STOCK AT YOUR NEIGHBORHOOD DISTRIBUTOR . . . ORDER NOW!

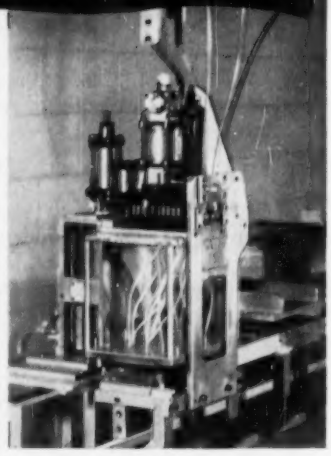
Now... MALCO AUTOMATIC PIN AND CONTACT INSERTING MACHINE FOR PRINTED CIRCUIT APPLICATIONS

. . . the Most Important Cost-Saving Advancement Yet Offered

Malco's Automatic Pin and Contact Inserting Machine can materially reduce your assembly costs—and at the same time step up production to practically any desired level.

Operation is completely automatic. Up to 40 or more self-retaining terminals are inserted into the printed circuit board in any symmetrical or non-symmetrical pattern within a 3-second cycle. A special platen engages the self-retaining snap-in feature of the terminals, and the board is ready for immediate further assembly and dip soldering.

Malco Automatic Inserting Machines can be engineered to your particular application or production requirements.



Request Bulletin 551. Better yet, give us the facts about your operation. We'll show you how your costs can be lowered and your production increased.

Malco TOOL and MANUFACTURING CO.
4023 W. LAKE ST., • CHICAGO 24, ILLINOIS

Electronics & Machine designs and manufactures standard and special types of r-f co-axial connectors.

Astatic Names Engineering Director

Fred Gluck

FRED GLUCK has been appointed as director of engineering of The Astatic Corp. of Conneaut, Ohio. He was formerly chief engineer of Fada Radio & Electric Co. He will direct and coordinate the various engineering activities at Astatic.

While at Fada, Gluck was responsible for all engineering activities involved in the design and manufacture of tv and radio receivers, and with that company's military electronics program. He was previously in engineering and sales administration with the Radiart Corp. of Cleveland.

New Missile Firm Formed

SYSTEMS RESEARCH CORP., a new company formed by a group of former Lockheed scientists who resigned last December following a policy dispute, began operations at its Van Nuys, Calif. headquarters.

Heading the company is Dr. Ernst Krause, former director of Lockheed's missile systems research laboratories branch. Dr. John L. Barnes, former director of Lockheed's computer and control laboratory, is serving as vice-president of the new company and Dr. Montgomery Johnson, former di-

PRECISION*

MODEL 2200
3½" x 12⅜" x 3⅞" • WT 5½ lbs.

Combination AC VOLTAGE DIVIDER & BRIDGE

* **ACCURACY:** *0.004% of input*
* **RESOLUTION:** *0.0005% of input*
* **PHASE SHIFT:** *0.05 Milliradian max.*
* **BRIDGING TRANSFORMERS:** *with specified max. error*

DESIRABLE ELECTRICAL CHARACTERISTICS

Frequency: 30cps to 3kc and higher •
Low Output Impedance • High Input Impedance

Also available: Unit for panel mounting

WRITE FOR COMPLETE DESCRIPTIVE LITERATURE

SOME AREAS AVAILABLE FOR REPRESENTATION

COAST COIL COMPANY WE 6-6188

MANUFACTURERS OF CUSTOM TOROIDAL WINDINGS AND PRODUCTS

Dept. A-1 5333 W. Washington Blvd., Los Angeles 16, Calif.

MOLYBDENUM

•

PURE and THORIATED TUNGSTEN

For ELECTRONIC APPLICATION

RIBBONS

STRIPS

FORMED PIECES

Your special metals rolled to thin sizes - close tolerances

H. CROSS CO.

15 BEEKMAN ST., N. Y. 38, N. Y.
WOrth 2-2044 and COrtlandt 7-0470

COMPLETE BURNER CATALOG

AGF, builders of gas burners and equipment for over 77 years offers this first complete catalog of technical data on air-gas and oxygen-gas burner equipment.

- **Sharp Flame, Fish Tail, Blast and Oxygen-Hydrogen Burners.**
- **Blowpipes, Hand Torches and Mixing Equipment.**
- **Flow Meters, Fire Checks and Ball Joints.**
- **Many accessories and much technical data.**

All of the above are available in the new AGF Burner Catalog, promptly mailed to you upon written request on your company's letterhead.

AGF

AMERICAN GAS FURNACE CO

130 Spring St. Elizabeth 4, N. J.

limitless...

Poly-Scientific's newly perfected manufacturing processes permit limitless variation in design . . . every part custom made to your individual requirements.

Poly-Scientific is synonymous with versatility, precision, and performance. Every slip ring, commutator, and brush assembly made by Poly-Scientific is the ultimate in quality.

The use of epoxy resins allows greater miniaturization without sacrifice of strength. Our perfected techniques permit the use of any of the noble metals and alloys, making possible the selection of the optimum material with the proper hardness for each specific application.

Dependable, long-life performance . . . minimum generated noise . . . freedom from tarnish . . . dimensional accuracy and stability . . . all of these are **automatic** when you specify Poly-Scientific. And best of all, prices are competitive.

miniaturized slip ring assemblies
brush assemblies
commutators

to fit any requirement

A real achievement in sub-miniaturization: thirty-two 0.140" diameter rings in less than one inch of length, with no sacrifice of electrical or mechanical characteristics! Rugged and accurate stainless steel flange and center rod insure perfect alignment. Solid coin gold rings of 140 Brinnel hardness are finished to a high polish. Also note color coded teflon insulated leads.

This extremely accurate commutator, used to generate a critical impulsing sequence, is fabricated with coin gold segments common to the end contact and P-30 epoxy resin, the combination of which guarantees uniform wear and long life.

Get the full story . . . write today for descriptive literature.

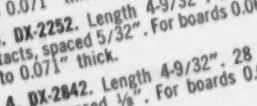
POLY SCIENTIFIC CORPORATION

Dept. E BLACKSBURG, VIRGINIA

for PRINTED CIRCUITS

Available in 5 Sizes

1. **DX-1052.** Length 2-13/32". 10 contacts, spaced 5/32". For cards 0.057" to 0.067" thick.
2. **DX-1852.** Length 3-21/32". 18 contacts, spaced 5/32". For boards 0.060" to 0.071" thick.
3. **DX-2252.** Length 4-9/32". 22 contacts, spaced 5/32". For boards 0.060" to 0.071" thick.
4. **DX-2842.** Length 4-9/32". 28 contacts, spaced 1/8". For boards 0.060" to 0.071" thick.
5. **DY-4453.** Length 4-9/32". Double row, total of 44 contacts, spaced 5/32". For printed circuit boards 0.062" to 0.100" thick.



Nylon plastic shells . . .
gold plated contacts

DX contacts of phosphor bronze; DY of beryllium copper. All contacts "grip" the board, which enters to a depth of approximately 11/32". Each rated at 5-amp. Polarization studs provided. Flashovers 2000 and 2500 v. 60 cps ac rms.

Single-row types for boards printed on one side only, or both sides common. Double-row type for boards printed both sides having different circuits, not common.

Please refer to Dept. 120

CANNON PLUGS

40th YEAR 1915-1955

CANNON ELECTRIC CO., 3209 Humboldt St., Los Angeles 31, California. Representatives and distributors in all principal cities

Want more information? Use post card on last page.

rector of Lockheed's nuclear physics laboratory, is the corporation's secretary-treasurer.

The new company expects to devote some of its energies to projects dealing with specific missile parts, but its primary aim is research and development work on the entire missiles system.

Narda Establishes Manufacturing Subsidiary

THE Narda Manufacturing Corp. has been formed as a wholly owned subsidiary of The Narda Corp.

The new company will manufacture uhf and microwave test equipment and detecting elements for The Narda Corp. In addition, the firm will engage in government contract and sub contract work relating to electronic test equipment.

Officers of the new corporation are: president, Dr. John C. McGregor; vice-president, William Bourke; vice-president in charge of engineering, Stuart Casper; vice-president in charge of manufacturing, James McFarland.

Oxford Division Appoints Plant Head

FRED BOECKER has been appointed plant manager of Oxford Electric's transformer division.

He comes to Oxford from the Rola Company of Cleveland, Ohio, where he was in charge of transformer operations. Prior to that, was in charge of transformer operations at Utah Products of Chicago.

Marvelco Names Design Director

CLARENCE B. KNUDSON has been appointed director of the newly formed product and applications design section of Marvelco Electronics division of National Aircraft Corp.

Knudson comes to Marvelco from Hoffman Laboratories where he was manager of the new products development engineering division. He has been vice-president in charge of engineering, Vantool, Inc.; director of engineering, Wash-

sturdy TEMFLEX 105...

Meets Military and Commercial Specifications

● Irvington's Temflex® 105 helps put *your* product in the strategic position of meeting both government and commercial insulation requirements. This versatile, flexible plastic tubing meets Mil-I-631-C specification (... far exceeds it!) Temflex 105 is QPL and UL approved as a 105° C. tubing. Improved heat deformation qualities and resistance to "cut through" give you 20% greater strength over older types. Self-extinguishable and fungus resistant Temflex is produced by Irvington's Plastics Department in all standard colors to fit all standard wire sizes. Send for literature and samples.

®Reg. U.S. Pat. Off.

IRVINGTON
DIVISION
Minnesota Mining and Manufacturing Co.
3M COMPANY
11 Argyle Terrace, Irvington 11, N. J.

Want more information? Use post card on last page.

SINCE 1920 QUALITY WENCO PRODUCTS

SPADE BOLTS

Specialists in designing and manufacturing of all-purpose fasteners and wire forms. Tooled to produce over 1000 styles in any screw size, material, finish, quantity, to your specifications.

Serving Industry for Thirty-five Years

— OTHER PRODUCTS —

Simplex
WIRE STRIPPERS & CUTTERS

• TOOLS • DIES • STAMPINGS

Bulletins on complete line upon request

WENCO MANUFACTURING CO.
1133 W. Hubbard St., Chicago 22, Ill., U.S.A.

Any marking problems?

- ENGRAVING
- ARC ETCHING
- NUMBERING
- LETTERING
- CALIBRATING

Also
Tracer Guided

- PROFILING
- SLOTTING
- MILLING

The world's largest specialist

offers a full line of portable and heavy duty engraving machines, with arc etching equipment.

24-PAGE BOOKLET EXPLAINS THESE FACTS:
- **Fastest set-up time for unskilled labor**
- **Covers a larger engraving area than any other machine of its kind.**

More than 15,000 in use.

Send for booklet 29
Write for name of nearest representative

new hermes ENGRAVING MACHINE CORP. 13-19 UNIVERSITY PLACE • NEW YORK 3, N. Y.

DIRECT READING OF FM DEVIATION . . .
25 to 500 mc. At Low Cost!

LAMPKIN 205-A
FM MODULATION METER

- Indicates instantaneous modulation deviation, positive or negative up to 25 KC.
- Accuracy 10% of full scale.
- Tunable 25 to 500 MC. in one band, with fast and slow controls.
- Sensitivity 10 millivolts or better throughout range.
- Speaker for aural monitoring, oscilloscope output for visual monitoring.
- Meets FCC specs for mobile-radio maintenance.
- Size only 7" x 12" x 7¼". Weight 13 lbs.
- Price $240.00 net. Satisfaction guaranteed or money refunded.

For measuring transmitter frequencies from 0.1 to 175 MC. (crystal-controlled transmitters to 500 MC.), within 0.005%, use the companion unit—the LAMPKIN 105-B MICROMETER FREQUENCY METER!

Write today for technical data on both instruments.

LAMPKIN LABORATORIES, INC.
Instruments Div., Bradenton, Florida

PRECISION PHASEMETER

o.1° ABSOLUTE ACCURACY
•
o.01° incremental accuracy
•
30 to 20,000 cycles per second
•
0 to 360° phase range
•
10-megohm input impedance (shunted by 25 $\mu\mu$f)

Output connection for strip-chart recorder.

Self-contained power supply for 105-125 volts, 50-60 cycles.

Adaptable to standard relay-rack mounting.

Price $3990 net F.O.B. Long Island City.

THE NEW MAXSON Model 901 Precision Phasemeter is a direct-reading electronic instrument adaptable to a wide variety of demanding measurement applications in computers, synchros, and amplifiers.

The instrument measures phase difference between two sinusoidal voltages; phase angles are read from a two-degree, step control with vernier indicator having a precision of 0.01°. Built-in sensing provides direct reading of proper quadrant. Accuracy is independent of even harmonics and of third harmonics up to 1%. Input-level range is from 0.5 to 10 volts rms.

Write or phone us for further information.

MAXSON INSTRUMENTS
A DIVISION OF THE W. L. MAXSON CORPORATION

47-37 Austell Place
Long Island City 1
New York
Tel: RAvenswood 9-1850

Acepot actual size

sub-miniature
Potentiometers (.3% linearity)
Trimmers (3% linearity)

Ace Dependable

. . . because they've been tested, tried, and proved in use!

ACEPOT (potentiometer)
200 Ω to 100K std., ±2%; ½" size; linearity .3% or better; highest resolution; weight ¼ oz.; temperature —55°C. to 125°C.; Std. bushing, servo or flush mtg., up to 6-gang units; 2 W. for 60°C. rise; low or high torque as required; meets MIL-E-5272A stds.

ACETRIM (trimmer)
10 Ω to 50K std., ±3%; ½" size; linearity 3%; excellent resolution; weight ¼ oz.; temperature —55°C. to 125°C.; 2 W. for 60°C. rise; low or high torque as required; meets MIL-E-5272A stds.

*Trademarks applied for

Why are ACEPOTS and ACETRIMS being written into the specifications of so much new equipment? Because they not only meet the requirements of space and weight saving compactness, but they also meet the *vital* requirement of *dependability.*

Special design and use of newest materials are features you get in ACEPOTS and ACETRIMS. The design is the result of 3½ years' development *and 1 year of successful use.* Ace's system of manufacture and exacting inspection and quality control assure you of highest quality standards. A Polaroid picture record is supplied with each ACEPOT showing linearity and resolution.

If you want sub-miniaturization, yet want to be sure of the performance and dependability of a heavyweight champion, consult Ace and you'll be right. Expedited delivery on prototypes. Prompt delivery on production orders. Send for catalog sheets and application data sheets.

ACEPOT* ACETRIM* **ACE ELECTRONICS ASSOCIATES**
Dept. E, 101 Dover Street • Somerville 44, Massachusetts

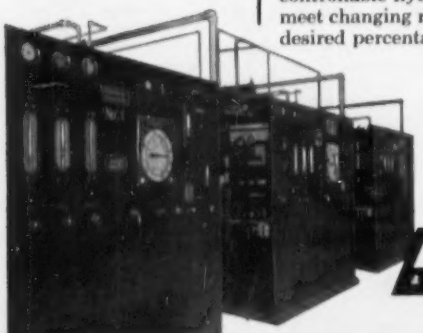
operation: FULLY AUTOMATIC, SAFE, HIGH PURITY, ECONOMICAL

results: PURE NITROGEN WITH CONTROLLABLE HYDROGREN CONTENT PRODUCED AT LOWEST COST

application: FOR MATERIAL OR PROCESS

NITRONEAL GAS GENERATOR

Pure nitrogen is produced by this equipment with a controllable hydrogen content that can be varied to meet changing requirements and maintained at any desired percentage between .25% and 25%.



Write for additional data on how the Nitroneal Gas Generator can be applied to your process or in your plant.

Request FREE, informative booklet No. 21.

BAKER & COMPANY, INC. PRECIOUS METALS
113 ASTOR ST., NEWARK 5, N. J.

ENGELHARD INDUSTRIES
NEW YORK • SAN FRANCISCO • LOS ANGELES • CHICAGO

ington Institute of Technology; section head, American Bosch Corp. and electronics engineer at Westinghouse.

Hewlett-Packard Plans Expansion

HEWLETT-PACKARD Co. of Palo Alto, Calif., has leased a 40-acre site in the Palo Alto area to build new manufacturing facilities. The property, owned by Stanford University, was leased for 99 years. The company hopes to begin construction in a year. The present plant and offices will be retained.

Infra Selects Chief Engineer

Fenimore Fisher

FENIMORE FISHER was promoted to chief engineer of the motor and generator division of Infra Electronics Corp.

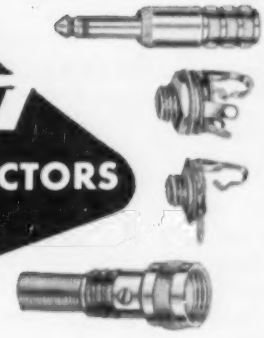
He formerly was senior engineer in the servo motor laboratory of the firm at the design level. Prior to joining Infra over five years ago, he was employed as design engineer by the Naval Aircraft Instrument Laboratory in Philadelphia.

Signal Engineering Changes Its Name

WHEELOCK SIGNALS, INC. is the new name of Signal Engineering & Mfg. Co., makers of relays, fire alarm systems, audible signals, code call system and auxiliary equipment.

The change, made to simplify the

tiny
ELECTROCRAFT
PLUGS·JACKS·CONNECTORS
in true miniature sizes

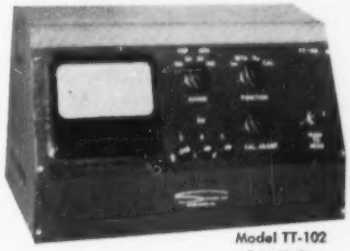


Plugs, jacks and connectors in true miniature sizes are now available for all electronic and industrial applications. The tiny plugs, 2 conductor type with combination clamp and solder lug terminals, pass the same 500 volt breakdown test as do plugs many times larger. Miniature jacks are also 2 conductor type, with either open or closed circuit. Tiny microphone connectors are available in both cord mounted and panel mounted types.

For plugs, jacks and connectors . . . standard or miniature . . . call on Electrocraft.

ELECTROCRAFT Division of Hamilton-Pax, Inc.
3743 N. Kedzie Avenue, Chicago 18, Illinois

Sonex **Transistor Tester**



Model TT-102
$150

A general purpose transistor tester for laboratory, field and industrial use. It measures and reads directly on a four inch meter the following transistor parameters:

Beta: 0-50 0-150 or as calibrated
I_{co}: 0-50 microamperes 0-150 microamperes
R_c: 0.02 megohms to 2 megohms

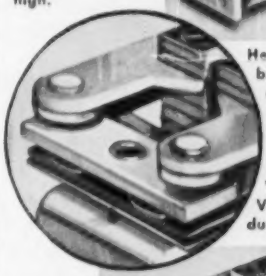
Write for descriptive literature
SONEX, INC.
245 Sansom St., Upper Darby, Pa.

Cosmic
CONDENSER SPECIALISTS SINCE 1923
ELECTROLYTIC & PAPER TUBULAR
CONDENSERS
For A.C., D.C. Sets - Phonographs etc.
COSMIC CONDENSER CO.
853 WHITTIER ST., BRONX
N. Y.

for
performance
quality
price
Phone — LU 9-3360

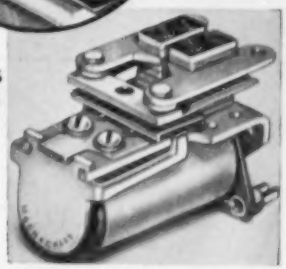
New Miniature
RELAYS
switch 20 amps. reliably

Class 11-D
For DC operation to 150 V. Minimum operating power, ½ watt. 1⅝" long, 15/16" wide, 1-7/16" high.



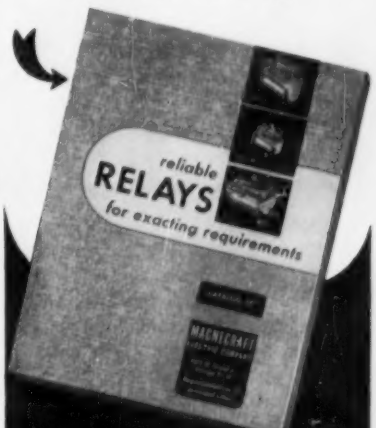
Heavy, double break contacts of 11-D and 22-D Relays—SPDTNO only. Rated 20 amps. at 115 VAC or 32 VDC, non inductive load.

Class 22-D
AC or DC



For AC operation to 440 V. or DC to 230 V. Minimum operating power, ½ watt. 2-1/16" long, 1-1/16" wide, 1-9/16" high.

Send for Catalog



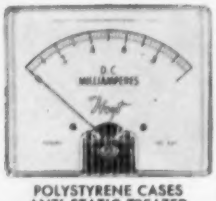
MAGNECRAFT ELECTRIC CO
3350B W. Grand Ave. Chicago 51, Ill

Want more information? Use post card on last page.

ENGINEERS • • •
SPECIFY *Hoyt* FOR – √ Accuracy
√ Appearance √ Economy

You get big advantages — optimum performance at minimum cost—when you specify HOYT Instruments incorporating more than 50 years' Manufacturing experience. HOYT offers you a complete Line of Panel and Portable Meters in a variety of sizes, ranges and cases . . . Milliammeters, Microammeters, Millivoltmeters, Ammeters, Voltmeters and others—Moving-Coil Repulsion and Rectifier Types—all designed for today's needs.

Take advantage of HOYT's lower cost! Write today for complete information and prices on the Meters you need.



POLYSTYRENE CASES
ANTI-STATIC TREATED

BAKELITE CASES
ROUND & SQUARE

METAL CASES
FLUSH & SURFACE

Hoyt ELECTRICAL INSTRUMENTS
Sales Div.: BURTON-ROGERS COMPANY
42 Carleton Street, Cambridge 42, Mass., U.S.A.

YOKE SPECIALISTS

COMPLETE LINE of deflection yokes for **every** need including military and special yokes. Focus Coils for tough problems. We'd like to help you with new applications. Write or phone Dr. Henry Marcy today.

syntronic
INSTRUMENTS, INC.
170 Industrial Road • Addison, Ill. • Phone: TErrace 4-6103

corporate name, is a change in name only and the business will be continued as heretofore by the present personnel with the same ownership, products and policies which have characterized the company over the past forty years.

The change of name follows the firm's recent move to larger and new plant facilities and offices at Long Branch, N. J. The company was previously located in New York City.

Zenith Establishes West Coast Lab

ZENITH Radio Research Corp. of California, subsidiary of Zenith Radio, established a research laboratory in Redwood City, Calif.

Winfield W. Salisbury will be director of research of the lab.

The laboratory will be concerned with electronic developments in areas outside the household radio and television field which may lead to diversification of the company's activities.

Jerrold Electronics Opens New Laboratory

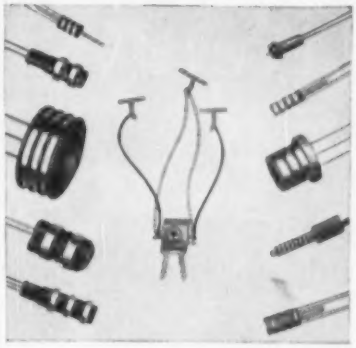
JERROLD ELECTRONICS CORP. dedicated its new 10,000 sq. ft research laboratory in Huntington Valley, Pa. In addition to the electronic research facilities, it includes a machine shop, plastic molding shop and two model shops for assembling prototype models.

Clary Names Two Engineering Heads

CLARY CORP. has appointed two assistant chief engineers to head new development programs for its electronic and data-processing equipment and for business machines.

Kenneth F. Oldenburg and Milton Scozzafava were promoted to the newly-established offices of assistants to Robert E. Boyden, chief engineer. Both have been engineering supervisors since 1952.

Oldenburg will continue in charge of the electronic and data-



Miniature and Sub-Miniature

SLIP RING ASSEMBLIES
BRUSH BLOCK ASSEMBLIES
COMMUTATORS

and other
Electro-Mechanical Components

PRECISION MADE TO YOUR OWN SPECIFICATIONS

Precision molded products with exacting tolerances in precious and non-precious solid metals of all alloys. All types of Thermo-Plastic and Thermo-Setting materials.

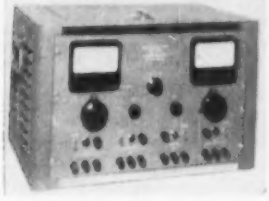
Slip Ring Assemblies fabricated or one-piece precision molded to your specifications in Nylon, Kel-F, Mineral filled Mellamine, Phenolic, and other materials. Rings and leads spot welded or brazed together for positive electrical circuit.

Our Swiss methods and techniques are geared to meet exacting requirements. We invite your inquiries.

COLLECTRON CORPORATION

MUrray Hill 2-8473 • 216 East 45th Street • New York 17, N. Y.

TWIN REGULATED POWER SUPPLY—$445.00



0-500ma 0-300v CONTINUOUSLY VARIABLE

Two completely independent high current supplies, fed from separate auto transformers. The + and — terminals of each supply are isolated from the chassis. Either may be grounded independently of the other. Each supply has a 2 stage DC amplifier, separate fusing and separate controls.

Each DC Supply:
0-300vdc, Vernier Control 5V
0-500ma at any output voltage
Ripple, noise: 3 mv rms
Output Impedance: 0.1 ohms DC.
3.0 ohms at 100KC
Regulation: Better than 0.5% for 10% line change. Available to .05%
Also contains two 6.3 VAC 10Amp taps.

WRITE FOR COMPLETE DESCRIPTIVE LITERATURE

PRESSMAN ASSOCIATES

7803 FARNSWORTH ST. PHILA. 15, PA.
DE 3-8064
Manufacturers Representatives—Territories Available

CONTROL FORCE MEASURING SYSTEM

that provides

1. Accurate measurements of better than 1/2%
2. Accurate measurements of pressure, force, acceleration, and position among others.
3. High gain with a frequency response of 15 cps.
4. Excellent operation under adverse environmental conditions.
5. Miniaturized and ruggedized construction.
6. Direct operation from resistive type transducers.

RADIATION Inc. Melbourne Fla. Orlando Fla.
Electronics • Avionics • Instrumentation
Personnel Inquiries Invited

BARBER COLMAN d-c motors

compact, powerful high quality for a wide range of applications

Looking for a d-c fractional hp motor of unusually high quality, high dependability? Specify Barber-Colman, the *versatile* line of small motors in both permanent magnet and split series types . . . in various mountings and speeds, and outputs up to 1/10 hp. Ideally suited to power electro-mechanical actuators, switches, blowers and programming devices. Barber-Colman small d-c motors are also available with lightweight radio noise filters to meet radio interference requirements of USAF. They are ideally suited for use as tachometer generators. Whatever your problem involving small motors, consult Barber-Colman Company for an expert solution.

Write for free catalog No. 100

BARBER-COLMAN COMPANY

Dept. D, 1459 Rock Street, Rockford, Illinois

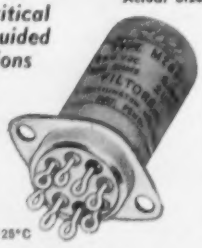
3 Relay Types by FILTORS, INC.

Now a Leader in the Sub-Miniature Relay Field

NEW—DPDT SUB-MINIATURE

Actual Size

Engineered for critical Airborne and Guided Missile Applications



TYPE: M26FC6

CONTACT RATING:
2 A Res. at 26.5 vdc or 115 vac
Dia.: .635
Mtg. Ctrs.: 0.875
Shock: 50 G
Vibration: 10 G at 5 to 2000 cps
Amb. Temp.:—65°C to +125°C
Weight: 1.3 oz.

NEW-LATCHING SUB-MINIATURE 6PDT

Magnetically Held—Electrically Reset

Actual Size

UNBELIEVABLY SMALL FOR A LATCHING RELAY

TYPE: L26F18

CONTACT RATING:
3 A Res. at 26.5 vdc or 115 vac
Mtg. Ctrs.: 1.406
Shock: 50 G
Vib.: 10 G at 5 to 500 cps
Amb. Temp.:—65°C to +125°C
(Also available in 2PDT and 4PDT)
Weight: 3.3 oz.

SUB-MINIATURE 4PDT

The Smallest, Hermetically-Sealed 4PDT Relay Available Today

Actual Size

TYPE: 26SR12

Mtg. Ctrs.: 1.406
Shock: 50 G
Vib.: 10 G at 5 to 500 cps
Amb. Temp.:—65°C to +125°C
Weight: 2.8 oz.

MIL SPECIFICATIONS
All Made to MIL-R-5757B and MIL-R-25018 (USAF)

DRY CIRCUIT RELAYS AVAILABLE IN PRODUCTION QUANTITIES

Write Today For New Catalog Listing Sales & Engineering Office Nearest You

FILTORS, INC.

30 Sagamore Hill Drive
Port Washington, L. I., N. Y.

Canadian Office:
MJS ELECTRONIC SALES, LTD.
P.O. Box 240, Ajax, Ontario
Tel.: EMpire 8-3806

Export Office:
MAURICE I. PARISIER & CO.
1860 Broadway, New York 23, N. Y.
Cable Address:
MIPARISIER NEW YORK

Want more information? Use post card on last page.

handling equipment department and Scozzafava of the business machines department.

Oldenburg joined the engineering department as a designer in 1946 and for the past few years has been in charge of the data-processing laboratory.

Consolidated Sets Up Data Laboratory

Robert L. Sink

CONSOLIDATED Electrodynamics Corp. has established an advanced electronic data laboratory.

The lab will undertake development of advanced equipment in the magnetic-tape data-processing field under contract to governmental and private agencies.

Named to head the Laboratory, which will be located in Pasadena, was Robert L. Sink, former assistant director of engineering for Consolidated.

He joined Consolidated in 1945 as chief electrical engineer. Previously, he had held engineering positions with Litton Engineering, Hewlett-Packard and GE.

General Controls Acquires Division

GENERAL CONTROLS Co. of Glendale, Calif., acquired the precision potentiometer division of Electro Circuits of Pasadena.

The new division is to operate as an independent unit with all Electro personnel continuing with

No more "priority"!

Expanded production enables us to offer our Telephone type twin-contact Relays to any industry.

For many years, Stromberg-Carlson production of twin-contact Telephone type relays has been completely absorbed by the independent telephone industry.

Last year, we became a division of General Dynamics Corporation. A five-million-dollar expansion program is under way and one result is already increased relay manufacturing facilities, enabling us to broaden our distribution.

These relays—proven by years of reliable service in the telephone field—are designed to operate under extreme ranges of temperature and humidity. They are made in many types of which these are typical.

Type A is a general-purpose relay especially adapted to the control of switching operations.

Type B is a gang-type relay which can be equipped with three times the number of spring combinations as the "A" type.

Type C. Two relays on the same frame; mounts in same space as the "A" type. It is particularly effective where small space is a factor.

Type D. Miniature general-purpose relay of approximately ⅓ the size of "A".

The catalog in the photograph above gives fuller specifications. We'll gladly send one on request.

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION • TELEPHONE INDUSTRIAL DEPT., 111 CARLSON ROAD, ROCHESTER 3, N. Y.

Want more information? Use post card on last page.

MARK 12 CAPS at one time with this machine

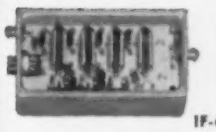
To meet the need for a small bench style marking machine that would provide quantity production at a specific point in an assembly line, this machine was developed.

Ask for literature and prices of the ACROMARK Model 926-LS Machine and send our Engineers a blue print or sample of parts marking you need for their recommendation of proper equipment.

The ACROMARK Company

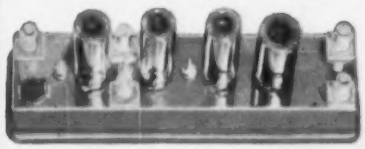
325 Morrell St., Elizabeth 4, N. J.

"The Original Marking Specialists"



IF-60

IF AMPLIFIERS *for* RADAR & GUIDED MISSILE *Application*

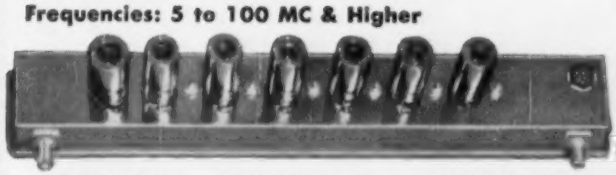


IF-31

Save valuable time in your development programs. Stock IF Amplifiers available for immediate delivery or modified to meet your end use requirements. Whatever your IF problem, contact our IF Engineering Department.

Frequencies: 5 to 100 MC & Higher

Write for literature and quantity prices —or submit specifications for units to meet your specific application.



IF-30 **FULL DETAILS Catalog EL-4**

• STANDARD • MINIATURE • SUBMINIATURE •

IF-21

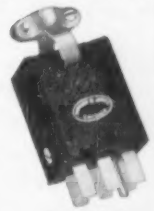
Formerly: LINEAR EQUIPMENT LABORATORIES, Inc.

LEL INC. AMityville 4-2200 380 OAK ST. **COPIAGUE, N. Y.**

For HIGHEST ELECTRICAL & MECHANICAL EFFICIENCY! *New*

JONES SERIES 2400 PLUGS & SOCKETS

- Improved Socket Contacts — 4 individual flexing surfaces. Positive contact over practically their entire length.
- Cadmium plated Plug and Socket, Contacts mounted in recessed pockets, greatly increasing leakage distance. INCREASING VOLTAGE RATING.
- Interchangeable with 400 Series.



P-2406-CCT

S-2406-SB

Send for complete Catalog No. 28. Plugs, Sockets, Terminal Strips.

Jones — HOWARD B. JONES DIVISION, CINCH MANUFACTURING CORPORATION, CHICAGO 24, ILLINOIS. SUBSIDIARY OF UNITED-CARR FASTENER CORP.

479®

PLATINUM ALLOY POTENTIOMETER RESISTANCE WIRE

Write for List of Products

- **HIGH TENSILE STRENGTH** To permit easy winding of Potentiometers and Coils.
- **CORROSION RESISTANT** Platinum Content provides unsurpassed resistance to corrosion . . long shelf life.
- **MAXIMUM STABILITY** of Electrical Characteristics. Available Bare or Enameled as small as .0004" diameter to as large as required. Resistance to 2500 ohms/ft.

SPECIALISTS in the UNUSUAL

SINCE 1901

SIGMUND COHN CORP.

121 SOUTH COLUMBUS AVENUE • MOUNT VERNON, NEW YORK

MARKEM® MACHINES

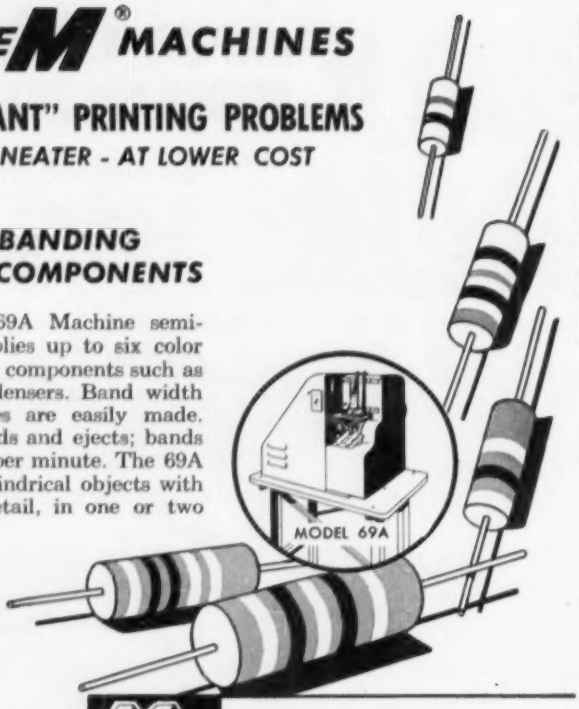
Solve "IN-PLANT" PRINTING PROBLEMS

- FASTER - NEATER - AT LOWER COST

COLOR BANDING WIRE LEAD COMPONENTS

The Markem 69A Machine semi-automatically applies up to six color bands to wire lead components such as resistors and condensers. Band width and color changes are easily made. Automatically feeds and ejects; bands about 50 objects per minute. The 69A will also mark cylindrical objects with complete label detail, in one or two colors.

Other Markem machines available for marking electrical parts and products of all sizes and shapes. Write for detailed information.



MARKEM MACHINE CO.
KEENE 8, NEW HAMPSHIRE

PHAZOR PAT. PEND

NULL METER

Manufacturers of:

PHASE METERS • NULL DETECTORS • IMPEDANCE COMPARATORS • POWER OSCILLATORS • VACUUM TUBE VOLTMETERS • FREQUENCY STANDARDS • AUTOMATIC HI-POT •

Other Electronic Test Equipment

A PHASE SENSITIVE NULL METER WHEREIN NOISE AND HARMONIC VOLTAGES ARE EFFECTIVELY ELIMINATED

MODEL 100A

PRICE $259.00 F.O.B. NEW YORK

- Allows separate balance of in-phase or quadrature in null circuits.
- Eliminates the necessity for filters.
- High sensitivity.
- Direction of null clearly shown on zero centered meter.
- Synchro zeroing without recourse to coarse and fine switching.

For further information contact your nearest representative or write for brochure

INDUSTRIAL TEST EQUIPMENT CO.
55 E. 11th ST. · NEW YORK 3 · GR. 3-4684

the division under the direction of Bruce Grimm, chief engineer.

Raytheon Elects New Treasurer

ALLEN E. REED has been elected treasurer of Raytheon. He has served as comptroller of the firm for the past nine years and will continue in that capacity in addition to the office of treasurer.

As treasurer of Raytheon, Reed succeeds D. T. Schultz, who joined Allen B. DuMont Laboratories as president.

Central Transformer Doubles Space

CENTRAL TRANSFORMER CO. doubled its manufacturing space by leasing additional space at its present location in Chicago.

M. R. Whitman is president and chief engineer; L. G. Shore is secretary-treasurer and general manager and F. J. Gallagher is manager of sales.

Feedback Controls Appoints President

WILLIAM M. PEASE has been appointed president of Feedback Controls, Inc. He formerly held the position of vice-president and general manager of the firm. He was v-p and manager of the electronic division of Ultrasonics Corp. and director of the servomechanisms lab at M.I.T., previously.

Lewyt Expands In Electronics

THREE Lewyt corporations will spend $10 million during the next 5 years in an expansion program.

The program started last July with the $2 million purchase of the Ford Instrument plant in Long Island City, N. Y. from the Sperry-Rand Corp. The newly acquired building has 315,000 sq ft of manufacturing space, but 43,000 more sq ft are being added. The expansion program will triple research and development facilities and double production capacity. In the

STAVOLT
POWER RECTIFIERS

30 Standard U.L. Approved Models

- Stationary or Mobile Types
- For Hangars, Air Fields, Missiles
- For Factories and Labs

Mag-Amp Control, Stable, Fast
15 to 1500 amps

Write for interesting information on STAVOLT RECTIFIERS

McCOLPIN-CHRISTIE CORP.
27th Year of Rectifier Manufacturing
3410 W. 67th St., Los Angeles 43, Calif.

lower costs . . .
improve design
save time . . .
with

GRC die cast GEARS & PINIONS

Cast in one piece, at one time — and *one* low unit cost! Produced precisely to your specifications, permitting a wide flexibility of ***design heretofore impractical.*** One-piece assemblies can be cast with shafts or center holes, or in combination with cams, hubs, spacers, flanges and other mechanical elements. Maximum size: 1-5/16" outside diameter x 1/16" face width; wider faces for smaller diameters.

MANY COMBINATIONS AVAILABLE FOR LESS PRECISE APPLICATIONS FROM STOCK DIES AT NO TOOLING CHARGE.

Write Today For Full Information and Samples

Send specifications for prompt quotation—100,000 to millions.

COMBINATIONS die cast in ONE piece!

GRIES REPRODUCER CORP.
World's Foremost Producer of Small Die Castings
151 Beechwood Avenue, New Rochelle, N. Y. • Phone: NEw Rochelle 3-8600

DANO COILS

LIFELINE
TO PRODUCTION

From design engineer to the purchasing agent to Dano—a perfect "lifeline" to production.

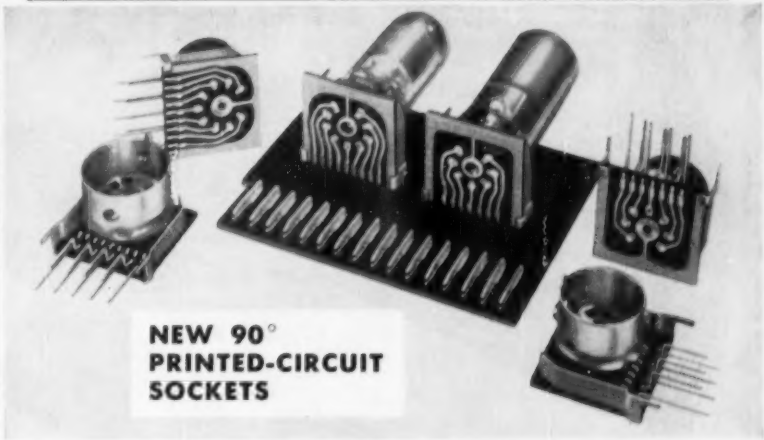
CALL or WRITE TODAY and DANO'S quote will be on the way.

- Bobbin Coils
- Form Wound Coils
- Paper Section Coils
- Acetate Bobbin Coils
- Cotton Interweave Coils
- Coils for High Temperature Applications
- Encapsulated Coils—in either Polyester or Epoxy Resins

Also, TRANSFORMERS MADE-TO-ORDER

THE DANO ELECTRIC CO.
MAIN ST., WINSTED, CONN.

IF IT'S NEW . . . IF IT'S NEWS . . . IT'S FROM ELCO



NEW 90° PRINTED-CIRCUIT SOCKETS

Newsworthy and newsmaking are Elco's new 90° Printed Circuit Sockets for 7-pin and 9-pin miniature tubes. These Elco quality components permit installation of the tubes in a position parallel to the printed-circuit chassis, thus conserving space where height is limited. The new sockets carry the same characteristics as standard miniature tube sockets. Furthermore, mounting brackets are designed to maintain rigidity and cannot be loosened from the chassis. For further information, please address your inquiry on your company's letterhead.

ELCO CORPORATION, M STREET BELOW ERIE, PHILA. 24, PA., CU 9-5500

Wanted:

by the industry's leading technical literature specialists

MANUALS

of the most superior quality

TO PRODUCE

most quickly and economically

The professional organization producing the greatest volume of technical literature in the electronics field is now available to you. We have complete facilities for organizing, writing and illustrating your operating and maintenance manuals for equipment—or any technical literature you may require—at substantial savings in time and money. Complete production and printing facilities are a part of our integrated operation. Your inquiries are cordially invited.

call or write **HOWARD W. SAMS & CO., INC.**

Special Services Division, 2201 E. 46th St., Indianapolis 5 • Phone: Glendale 4531

Ask for it

We'd like to send you our brochure: "The Story of a Unique Service"

Need Heavy Duty
TRANSFORMERS OR ELECTRONIC EQUIPMENT?

It's your move—

Our Ability is Unlimited

TRY US

WRITE FOR LITERATURE . . .

MAGNATRAN Incorporated

P.O. Box 211 KEARNY, NEW JERSEY, U.S.A.

near future the firm will have manufacturing and assembly facilities for over 6,000 employees.

Each of three companies has been allocated a good slice of the $4 million expansion pie for the coming year.

The Lewyt Manufacturing Corp., makers of electronic and electromechanical equipment for the military and private industry, plans a new research and development laboratory, new test chambers, new vibration and shock test equipment and new plating gear.

Crosby Labs Promotes Coffman

BARTON C. COFFMAN has been named chief engineer of Crosby Laboratories of Hicksville, N. Y. He joined the firm in 1951 as senior engineer. He was later advanced to the post of research associate.

Lambda Electronics Pushes Output

Lambda Electronics plant

LAMBDA Electronics Corp., manufacturers of power supplies, is in full production at its new plant at 11-11 131 st. in College Point, N. Y.

ESC Appoints Production Chief

ESC CORP., of Palisades Park, N. J., manufacturer of delay lines, appointed Melvin Traum as production manager.

Previous to his appointment at ESC, Traum was associated, for twelve years, with the guided missile division of Federal Telecommunication Laboratories.

sonic energy using piezoelectric,

YOUR BEST SOURCE

COILS

THAT ARE

ENGINEERED FOR QUALITY

- TRANSMITTER
- R.F.
- OSCILLATOR
- I.F.
- CHOKES
- RELAY
- PEAKING
- MAGNET
- FILTER
- SPECIALS

N. Y. AREA REPRESENTATIVE:
BEN JOSEPH & ASSOC.
521 FIFTH AVE.
NYC 17—MU 2-8945

COILS-ELECTRONICS CO.
2943 N. 2nd ST.
PHILADELPHIA 33, PA.
REgent 9-6465

SOME TERRITORIES OPEN
TO QUALIFIED REPRESENTATIVES

An Invitation
TO MANUFACTURERS
OF ELECTRONIC EQUIPMENT

1. Friendly labor supply.
2. Unusual city, county, and state tax advantages.
3. Industrial sites plentiful.
4. Good banking facilities.
5. Full cooperation guaranteed.
6. Strategic location.

for
SMALL
or
MEDIUM
INDUSTRIES

Businessmen of Lakeland, Florida will cooperate fully and furnish complete information to manufacturers who will consider relocating or establishing a branch unit in this fast-growing central Florida city . . . . .

INDUSTRIAL DEVELOPMENT COMMITTEE OF 100
LAKELAND TERRACE HOTEL

LAKELAND, FLORIDA

Before You Can Make a Reliable Electric Connection

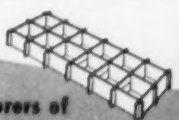
1. The insulation must *first be removed.*
2. *ALL* the insulation must be removed.
3. The conductor *must not be nicked* or reduced in diameter.

Developing a method and equipment for a specific high-quality, high speed stripping operation requires full consideration of all the factors peculiar to that job. In most cases, standard equipment (often with adaptations) will do the job; in others, special methods must be developed.

Our specialty is studying your specific applications and recommending an efficient wire-stripping method.

Ask for FREE 24-Page Book, "Reliable Electrical Connections"

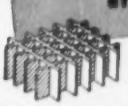
Rush Wire Stripper Division
THE ERASER CO., INC.
1068 S. Clinton St., Syracuse 4, N. Y.



For manufacturers of Radio, Electrical and Electronic components and allied products!

Pre-assembled ...custom-made

PARTITIONS
for Protective Packaging
made to your exact specifications
for faster packing at lower cost!

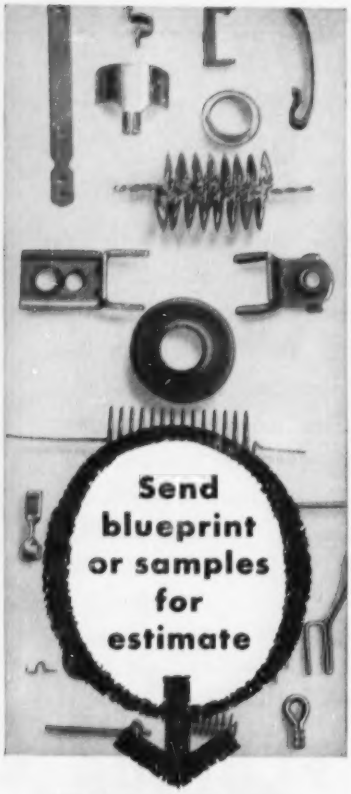


WRITE, PHONE or WIRE for QUOTATIONS on YOUR REQUIREMENTS

PETER PARTITION CORP.
for the second time in 10 years
EXPANDS ITS FACILITIES!

NOW, in our new location—in double the space we occupied at our former address—we are operating one of America's largest plants devoted exclusively to the production of cardboard partitions. ...Customers' needs can be served better than ever before in our new and enlarged plant...Production is keyed to the steadily increasing demand for our specialized service.

PETER PARTITION CORP.
Manufacturers of Cardboard Partitions
124 BOERUM PLACE **BROOKLYN 1, N.Y.**
Telephone: TRiangle 5-4033



WIRE FORMS

and

METAL STAMPINGS

We'll prove that our high speed production means lower unit costs for you!

You'll save two ways — (1) the initial low unit cost made possible by high speed machines; (2) precision and quality control guarantees accurate parts and performance.

STRAIGHTENING AND CUTTING
Perfect straight lengths to 12 feet.
.0015 to .125 diameter.

WIRE FORMS
.0015 to .125 diameter.

SMALL METAL STAMPINGS
.0025 to .035 thickness.
.062 to 3 inches wide.

Specializing in production of parts for electronic, cathode ray tubes and transistors.

Write for illustrated folder.

ART WIRE AND STAMPING COMPANY

1 Boyden Place • Newark 2, New Jersey

Want more information? Use post card on last page.

New Books

Ultrasonic Engineering

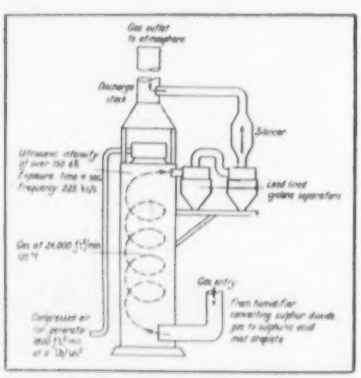
By A. E. Crawford

Academic Press Inc., New York, 1955, 344 *p*, $8.00.

THE contents of this book deal with a subject which has been rapidly increasing in importance over the past decade, although a large percentage of engineers are totally unfamiliar with it. The object of the book is to present and correlate data on the applications and effects of ultrasonic waves and to cover some basic methods of generation of ultrasonic energy. Emphasis is placed on the practical aspects of ultrasonics and not on mathematical analysis.

The book is divided into sections covering: theory, generation and applications.

▶ **Basic Theory**—In the first section the author discusses basic ultrasonic theory including types of waves, standing waves, energy and frequency measurement, and the phenomenon of cavitation. The properties of absorption, reflection, refraction and beaming of ultrasonic waves are described. Basic equations are presented. These equations although brief, are informative. A group of tables of velocity of sound, specific acoustic impedance and density of a large number of liquids, solids, gases and metals are included which are helpful in designing ultrasonic generators.



Schematic arrangement of acid fog precipitation using sonic agglomeration

▶ **Generators**—The second section deals with the generation of ultrasonic energy using piezoelectric, magnetostrictive and electromagnetic transducers. Also included is an interesting chapter on ultrasonic generation by high-velocity jets of liquids and gases. The theory of operation and practical design considerations of the various types of transducers mentioned are adequately discussed including forms of coupling and methods of mounting.

▶ **Applications**—The third section, which occupies more than half the book, is concerned with practical high-power applications of ultrasonic energy in the fields of chemistry, metallurgy, and medicine. In addition descriptions are given of instruments employing ultrasonic waves for drilling, soldering, dust precipitation and equipment for use in underwater applications. Excellent qualitative information on the actual processes involved in applying ultrasonic energy to perform various tasks and descriptions of commercially produced laboratory and industrial instruments are contained in this section.

The excellent graphs, tables, photographs and drawings help to a large extent in making this book a fine introduction to the field of ultrasonics for engineers unfamiliar with the subject. It is also a valuable source of information to those interested in familiarizing themselves with the capabilities of ultrasonic energy for the purpose of possibly converting their standard methods of processing to ultrasonic methods with the object being improved efficiency and economy, among other things.—S. A. Gitlin, *Dept. of Electrical Eng. Electronics Research Labs, Columbia University, New York*

Linear Feedback Analysis

By J. G. Thomason. *McGraw-Hill Book Co., New York,* 1955, 348 *p*, $8.50.

"Linear Feedback Analysis" is an introductory, analytical treatment of feedback-circuit analysis, which emphasizes stability theory and design techniques for stabilizing feedback amplifiers. The book is written at a level which should be readily understood by seniors or graduate

electronics engineers:

Here's How

and your family

you can enjoy
all the EXTRAS at the
BALTIMORE DIVISIONS
of
Westinghouse

This is BALTIMORE:

BALTIMORE:

"City of monuments," in the heart of the Chesapeake Bay area . . . famous for its sailing, fishing, swimming and upland hunting. Historically, the hub of our independence and birthplace of the "Star Spangled Banner." Big city advantages with small town atmosphere.

FOR THE ENTIRE FAMILY:

Professional and intercollegiate sports, a world-renowned symphony orchestra, outstanding public library facilities and art galleries, legitimate theater, three television stations. Many active church and civic organizations.

FOR YOUR CHILDREN:

A modern, complete and ably-staffed public education system. One of its high schools has a nationally-famous pre-engineering course. The area also boasts several well-known and highly respected colleges and universities. Skillfully planned park and playground facilities.

FOR YOUR WIFE:

Expansive "Downtown" facilities, plus the convenience of modern suburban shopping centers. Well planned home developments and individual homes, built to meet any desired budget.

FOR YOU:

At the Baltimore Divisions of Westinghouse . . . Liberal relocation allowances, advanced education at Company expense, excellent employee benefits, interesting projects in association with recognized leaders in the industry, together with truly *unlimited opportunity*.

This is Westinghouse in Baltimore

AIR ARM DIVISION:

Pioneer in airborne electronics, developer of the world's *first* automatic electronic airborne fire control system. Today's advanced projects will win still more respect for this outstanding division . . . and *you* can share in its future!

ELECTRONICS DIVISION:

Chief supplier of transmitting and radar equipment for the Navy during World War II, this division is today engaged in challenging projects covering the entire scope of ship and landborne electronic equipment. At this writing, work is progressing on the construction of an ultra-modern plant to house advanced military electronics projects.

Westinghouse Baltimore Divisions are proud of their achievements in electronics, and proud, too, of the men who have made them possible. The past success of the Divisions offers to all qualified engineers an assured future . . . in the most modern of plant facilities, and with an established *leader* of the electronics industry.

Visit us during your VACATION

Because Maryland *is* a state of scenic, recreational and historical importance, you and your family would enjoy a summer vacation in this area. We will be happy to forward an illustrated historical map of the State upon request.

Better yet, send us your resume now . . . so that a convenient interview may be arranged during your vacation. Naturally, we would expect to reimburse you for reasonable expenses incurred between your home and Baltimore.

BOMARC

TYPICAL OF THE
ADVANCED PROJECTS AT

Westinghouse

BALTIMORE DIVISIONS

BOMARC is typical of the many interesting projects "in the works" at Westinghouse. Such projects are more than a "one-shot" challenge to the engineer . . . they are the true steps forward in his career, and the broadening of knowledge that enriches his value to himself and to his profession. If you are interested in this type of project, Westinghouse is interested in you!

OPENINGS

- CIRCUITRY
- MICROWAVES
- SERVOMECHANISMS
- MAGNETIC AMPLIFIERS
- DIGITAL COMPUTER PROGRAMMING
- FIRE CONTROL SYSTEMS
- PACKAGING
- TRANSFORMERS
- ANALOG COMPUTER DESIGN
- VIBRATION
- RADAR DESIGN
- FIELD SERVICE

TO APPLY

Send letter outlining your education and experience to—
Technical Director, Dept. A
Westinghouse Electric Corp.
2519 Wilkens Avenue
Baltimore 3, Md.

YOU CAN BE **SURE**...IF IT'S

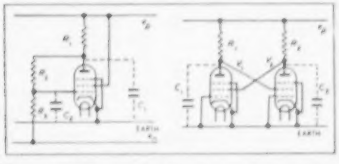
Westinghouse

electrical engineers.

The first third of the book is devoted to the mathematics basic to stability analysis, with chapters on a-c circuit analysis, Laplace transforms, and examples of transform analysis.

The middle section, of five chapters, is devoted to amplifier analysis and design, with detailed descriptions of the design and stabilization of biasing and coupling circuits for vacuum-tube feedback amplifiers. Primary emphasis is on the gain-phase analysis, and the discussion leads to a presentation of common stabilizing networks.

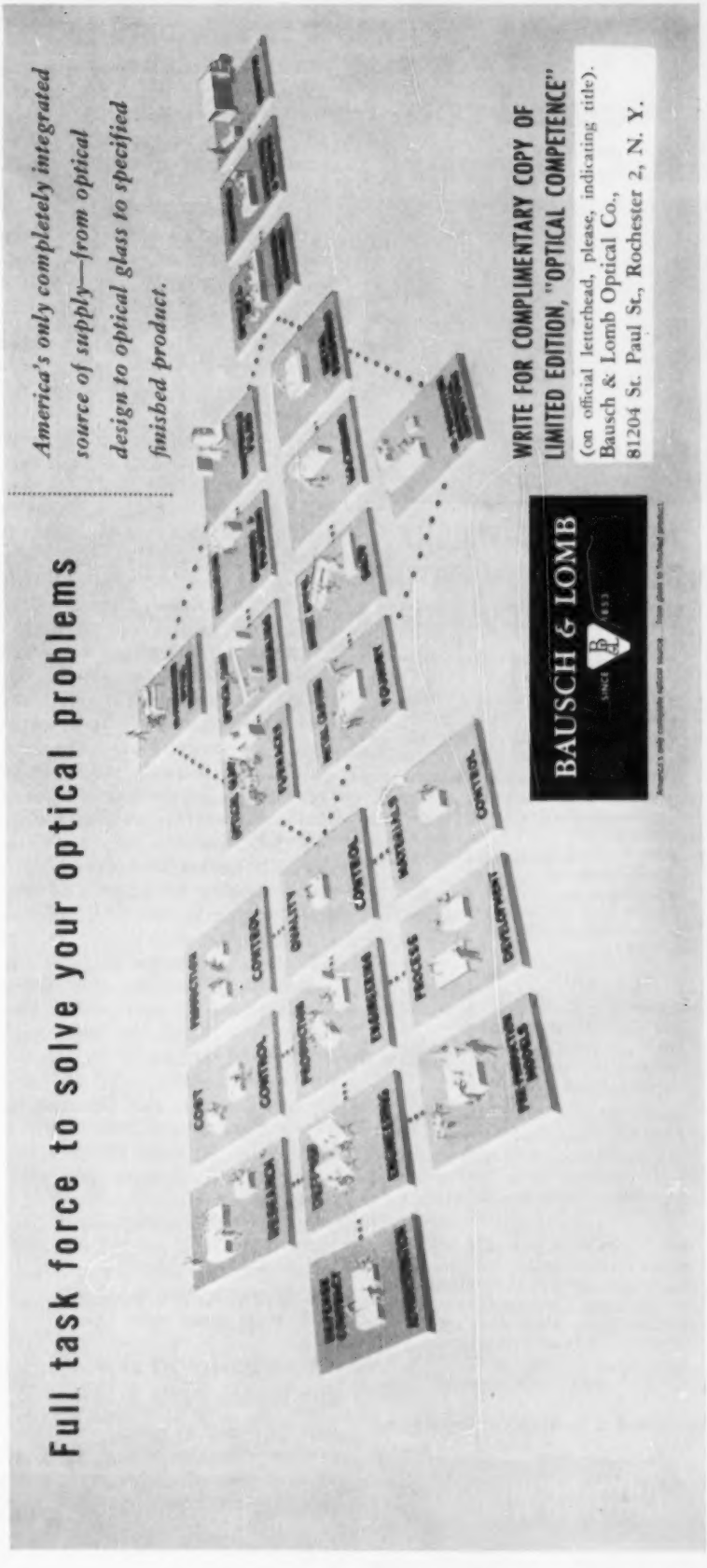
► **Circuits**—The final section of the book includes discussions of a number of typical, linear feedback amplifier circuits, particularly drawn from the field of nuclear instrumentation, but of rather general interest. Circuits discussed include the cathode follower, various operational amplifiers (in considerable detail), a current amplifier for an ionization gage, a pulse amplifier as used in counting instruments, an audio amplifier with transformer-speaker load, and several electronically regulated power supplies.



The stability of feedback systems. Two lags, negative feedback; two lags, positive feedback

► **Theory**—The middle chapters represent the core of the design theory, as the author presents the concept of Nyquist diagrams and then turns to gain and phase plots. The gain-phase relations are discussed, the limitations on gain and phase are considered, and the stabilization problem is presented largely in terms of the gain-phase plots.

The discussion of theory is consistently clear and presented in terms of concrete, easily followed examples. Thus, although the theoretical development only rarely goes beyond and usually does not go as far as Bode's bible in the field, the


Full task force to solve your optical problems
America's only completely integrated source of supply—from optical design to optical glass to specified finished product.
WRITE FOR COMPLIMENTARY COPY OF LIMITED EDITION, "OPTICAL COMPETENCE"
(on official letterhead, please, indicating title).
Bausch & Lomb Optical Co.,
81204 St. Paul St., Rochester 2, N. Y.
BAUSCH & LOMB
SINCE 1853

Want more information? Use post card on last page.

NOW... Noise Free A.C. Power!

NEW CURTISS-WRIGHT DISTORTION ELIMINATING VOLTAGE REGULATOR

- Reduces typical power line distortion to less than 0.3%
- Furnishes 1.4 KVA of distortion-free power
- Electronically regulates 115 V output to ±1%
- Recovery time less than 1/50 cycle
- Provides additional 4 KVA of ±1% electromechanically regulated power
- Electromechanical time constant only 0.6 seconds
- Electromechanical regulator, unlike usual magnetic voltage stabilizer, introduces no distortion or phase shift

Here at last is the ideal solution to the disturbing problem of harmonics and low frequency noise appearing in 115 V., 60 cps power sources. In one compact package, every laboratory can now obtain *both*

1) distortion-free, regulated power when needed, and simultaneously

2) a large supply of electromechanically regulated power for applications where normal line distortion is tolerable.

In addition to its general laboratory utility, this instrument is ideally suited for preventing instability and inaccuracy in a.c. computer system nulling operations. Many other applications. 230 V. model also available. Immediate delivery. $1,689 f.o.b. Carlstadt, N. J. Write for details.

Component & Instrument Department

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

Want more information? Use post card on last page.

book seems to be a definite contribution in the dissemination of the basic ideas of stabilization.

In this sense, the book closely parallels a number of servo books, such as G. J. Thaler's "Elements of Servomechanism Theory," except of course that in Thomason's book the examples are drawn from the feedback-amplifier field rather than the servo field.

▶ **Feedback**—There are a number of fundamental aspects of the feedback-amplifier subject which the author chooses not to discuss in order to emphasize the basic techniques of stabilization. For example, there is practically no real utilization of transform methods in design, once the Nyquist criterion is established.

Perhaps more important, there is only a very brief discussion of the effects of feedback on sensitivity, impedances, distortion, etc. The especially brief treatment of sensitivity (the return difference is not included in the index) is unfortunate in the reviewer's opinion, since stabilization is really necessary in the majority of cases only because of the desire for low sensitivity. Likewise, there is essentially no clear distinction between negative resistance and instability and only a hurried disposition of conditionally stable systems.

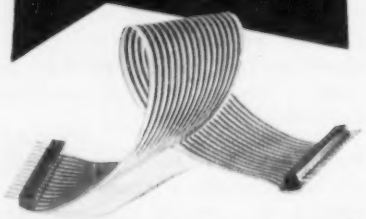
Comment on these omissions is unjust, however, since the author is not trying to present feedback theory, but rather the basic, commonly used techniques for the design and stabilization of feedback amplifiers, and in this direction he has succeeded admirably with a book which is easily read, replete with interesting examples, relatively free of errors, and in a comparatively under-published field—JOHN G. TRUXAL, *Associate Professor, Polytechnic Institute of Brooklyn, Brooklyn, New York*

The Physics of the Ionosphere

THE PHYSICAL SOCIETY.
London, England, 406 *p,* 1954, 40 *shillings (paper).*

THIS BOOK is the report of the Physical Society conference held

NOW! Flexible Kel-F PRINTED CIRCUIT CABLES



Kel-F®

developed by
Sanders Associates, Inc.

By means of an exclusive Sanders process, the versatile plastic Kel-F can now be laminated with copper in thin sheets to provide a flexible printed circuit cable. This unique development introduces an entirely new concept in the fabrication of multi-conductor cables or wiring harnesses. Excellent electrical and mechanical properties are supplied for operation over a wide range of environmental conditions. The complete encapsulation of the conductors in Kel-F ensures maximum protection against moisture. Glass cloth can also be included in the laminations for increased strength and high temperature srability.

FEATURES

- Excellent dielectric strength
- High degree of flexibility
- Lighter, thinner than many cables
- Maximum environmental protection
- Adaptable to many connectors
- Multi-layer construction available
- Suitable for chassis harnesses
- Wiring errors are eliminated
- Easily mounted

Write for engineering bulletin to Dept. E4

SANDERS ASSOCIATES
INCORPORATED

Want more information? Use post card on last page.

at the Cavendish Laboratory, Cambridge in September 1954. It contains 50 papers, 45 of which are in English with 3 in German and 2 in French.

The report is in four parts: the lowest ionosphere, 10 papers; irregularities and movements in the ionosphere, 17 papers; the ionosphere F2 layer, 9 papers; the mathematics of wave propagation through the ionosphere, 14 papers.

Arrangement

Each section is introduced by a survey article to bring the reader up to date on present knowledge in the field. An addendum to each survey article summarizes the major points brought out during the conference. The four survey articles provide a good introduction to the subject of ionospheric radio propagation.

The paper Scattering at Oblique Incidence from Ionospheric Irregularities by D. K. Bailey of NBS reports transmissions of 1,200 km on frequencies on the order of 50 mc by forward scattering from irregularities in the E or D regions, the power of the transmitter being about 30 kw. This sort of phenomenon has assumed considerable importance in military uhf point-to-point communications.

The Ionospheric F2 Region by R. J. Havens, H. Friedman and E. O. Hulburt of NRL reports on compostion and temperatures in the upper atmosphere. The data was obtained during rocket flights that attained altitudes up to 219 km. —J.M.C.

Microwave Spectroscopy

By C. H. Townes and A. L. Schawlow

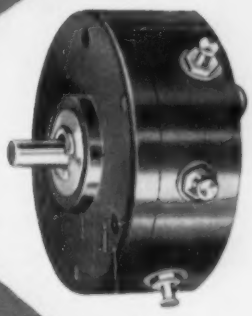
McGraw-Hill Book Co., Inc., New York, 1955, 698 *p*, $12.50.

Yet another book of the same title to come out within a couple of years. The first, by Walter Gordy et al, was published by John Wiley in 1953, and the second, a Methuen Monograph by M. W. P. Strandberg, in 1954. Both books were reviewed in Electronics (October 1953 and June 1954, respectively). In reviewing the latter, the re-

Get Precision at a New Low Price!

GAMEWELL'S

G-20 SERIES



PRECISION POTENTIOMETERS

The New G-20 gives you a truly precision potentiometer with many characteristics found only in pots costing twice as much. Here are the outstanding features . . .

- Linearity is 0.5 or better
- Radial or Rear Extension Turret Terminals
- Non-metallic housing uses material of high dimensional stability that is inherently fungus-proof and moisture resistant
- Servo, Threaded-Bushing or Flange Type Mountings
- Power rating 1.5 watts at 65°C (derated to 0 at 150°C)

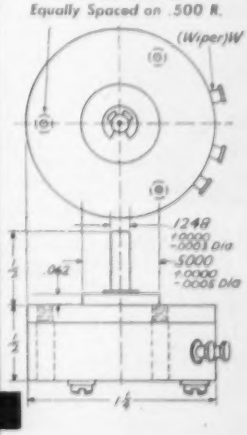
Gamewell gives you this high quality at low cost by new design techniques and high production methods.

See how many applications can use this new G-20. It is ideal where you require *good* precision at a bargain price for industrial and commercial apparatus. Gamewell is ready to supply these in quantity now.

Technical Data

Resistance, Max.	63,000 ohms ±5%
Resistance, Min.	20 ohms ±5%
Linearity Std.	±0.5
Electrical Angle	340° ±3°
Max. No. of Turns	2100
Watts at 65°C	1.5
Torque Max.	1 oz. — in.
Max. Temperature	150°C
Weight	1¼ oz.

4-40 NC-2B 3-Holes Equally Spaced on .500 R.



GA 6-2

THE GAMEWELL COMPANY
NEWTON UPPER FALLS 64, MASS.

GAMEWELL®

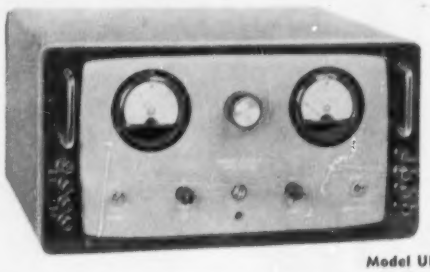
PRECISION POTENTIOMETERS

Manufacturers of Precision Electrical Equipment Since 1855

Want more information? Use post card on last page.

REGULATED POWER SUPPLY

With 100 Microvolts Hum



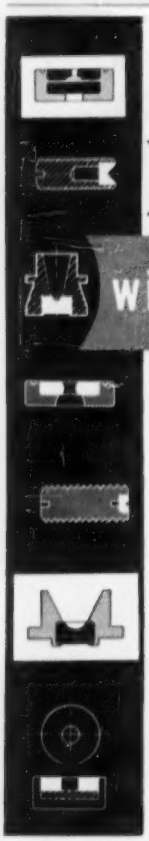
Model UHR-245

Krohn-Hite Model UHR-245 ULTRA-HIGH REGULATION POWER SUPPLY furnishes continuously variable voltage from 150 to 500 volts and delivers up to ½ ampere of DC current with 0.002% load regulation and less than 100 microvolts of ripple over the *entire operating range*. The internal impedance is less than 0.01 ohm for DC and low frequencies and less than 0.05 ohm for frequencies as high as 50 kc. Full rated maximum current can be drawn with 100% duty cycle at any output voltage and at any line voltage from 105 to 125 volts with a substantial safety factor. There are two independent 6.3 volt AC 10 ampere outputs. Price $375.00 f.o.b. factory.

For Further Details Write

KROHN-HITE INSTRUMENT CO.

DEPT. E, 580 MASSACHUSETTS AVE., CAMBRIDGE 39, MASS.



INSURE TOP INSTRUMENT Performance

with Bird jewel assemblies

Made under rigid quality-control throughout manufacture. Bird complete jewel assemblies come ready to install . . . saving production time . . . eliminating rejects . . . cutting costs.

Bird jewels are custom mounted to your specifications, by skilled craftsmen. All assemblies are thoroughly inspected . . . carefully packaged . . . shipped to meet critical production schedules.

And the cost — far less than trying to make the same assemblies in your own plant — actually only pennies to insure perfect performance for your instruments.

Why not discuss the use of jewel bearings or special assemblies with the Bird engineering staff — they are always at your service for all types of jewel bearing problems — no obligation of course.

For information on Bird Jewel Assemblies write for Bulletin 5.

Over 40 years of serving industry with Quality jewel bearings

Richard H. Bird & Co., Inc.

1 Spruce Street, Waltham 54, Mass.

SAPPHIRE AND GLASS JEWELS, PRECISION GLASS GRINDING, JEWEL MOUNTING AND ASSEMBLY, SAPPHIRE STYLII

viewer pointed out that among American universities, Columbia, Duke and M. I. T. were perhaps the foremost in the field of microwave spectroscopy. Duke and M. I. T. having made their contribution, it now behooves Columbia University to bring forth the present volume, which is perhaps the most all-encompassing yet, not only because it is more recent, but also because of the exhaustive treatment: the book draws on a bibliography of some 1,200 items, with information to match.

▶ **Molecules**—But this is no mere compendium of tables, graphs, and other information of the handbook type. Rather, the treatment starts with a consideration of the simple diatomic molecules, followed by the increasingly complex cases of linear polyatomic molecules, symmetric-top molecules, and asymmetric-top molecules. The authors go on to discuss some of the fine and hyperfine effects, the study of which has been made possible by the use of microwave technique for the first time.

Of the book's eighteen chapters only three are concerned directly with instrumentation: one on microwave circuit elements and techniques, one on microwave spectrographs, and one on methods of measuring and controlling frequency. There is also a short chapter on the production of millimeter waves, a topic on which the Columbia group is particularly competent to report, since they have made some notable contributions to this field.

▶ **Impact**—There are few instances in which electronics has had such a profound influence upon related fields as microwave spectroscopy has had on physics and chemistry (and promises to have on chemical analysis). The authors speak of the "furious activity" that has made their task especially difficult, both because of the huge amount of results becoming available all at once, and because of the rapid development of ideas and techniques that is sure to make any published survey obsolete quickly. They have addressed themselves to this task with a result that is certainly im-

Up to date production facilities using the most modern high speed, automatic machinery producing quality components for the Electronics and Telecommunications Industries.

Automatic's high standards of quality are based on over 15 years experience manufacturing precision parts for the Army, Navy, Air Force and Atomic Energy Commission.

Prompt engineering service is available for design and production of any special connector or component you may require.

Manufacturers of

RF FITTINGS • RF CONNECTORS COAXIAL RELAYS • COAXIAL SWITCHES • INSULATED CONNECTING RODS AND SHAFTS • POWER PLUGS • AUDIO PLUGS • COAXIAL CABLE ASSEMBLIES

WRITE, WIRE OR PHONE FOR FURTHER INFORMATION.

Automatic
METAL PRODUCTS CORP.

371 Berry Street, Brooklyn 11, N.Y. • EVergreen 8-0364

Want more information? Use post card on last page.

pressive, producing a book that is both timely and likely to remain a standard work for some time to come.

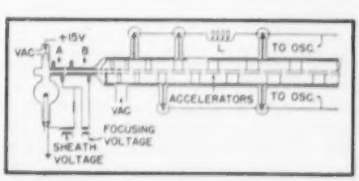
C. H. Townes is Professor of Physics at Columbia University, and A. L. Schawlow, formerly also associated with Columbia, is a member of the staff of the Bell Telephone Laboratories. They are to be commended for undertaking to write such a major work, and to be congratulated as to the extent of their success in accomplishing their avowed intent "to discuss the material critically, systematically, and in the simplest way consistent with some completeness in a single volume."—CHARLES SUSSKIND, *University of California, Berkeley, Calif.*

Introductory Nuclear Physics

By DAVID HALLIDAY. *John Wiley & Sons, Inc., New York*, 1955, 493 *p*, $7.50.

INSTRUMENTATION for studying nuclear phenomena and for controlling reactions depends heavily upon electronic circuitry. This puts the electronic engineer into the nuclear energy business and it behooves him to have more than a nodding acquaintance with this new, complex and rapidly moving science.

This book is designed as an introductory text on the undergraduate level. Nevertheless, the material presented in small type and the appendixes contain material sufficient for a course on the first-year graduate level.



Halliday linear accelerator for heavy ions

▶ **Content**—The book covers radioactive decay and alpha emission, gamma radiation and internal conversion, behavior of gamma rays, beta decay, detection of charged particles. Also: neutrons, nuclear

In professional fields, Magnecord has long been established as first choice. Now the P60-A Editor sets new standards in professional installations.

The Editor has all the easy, accurate editing features of the most expensive models — with the greatest number of operating features ever built into a tape recorder for such a low-cost investment.

Before you decide, check the specifications of the new Editor. To be convinced, hear and operate the Editor yourself.

Whatever your requirements, there's a Magnecorder to fit the job. The Hi-Fi Pro or the Citation is an excellent accessory unit at moderate cost. The fabulous M-90 is the finest professional tape recorder made today.

Magnecord, inc.
The Choice of Professionals
1101 S. KILBOURN AVE.
CHICAGO 24, ILLINOIS
Export: Ad. Auriema, Inc.
89 Broad Street, New York, N. Y.

Want more information? Use post card on last page.

For
PILOT LIGHTS
CONSULT
DIALCO

Your product benefits 3 ways from the use of a DIALCO Pilot Light:

Enhanced appearance: The glow of light and sparkle of a lens add colorful visual attraction.
Greater safety: A timely warning flashed by a pilot light can prevent damage to equipment.
Added service: Discs inserted behind lenses can be used to deliver specific messages, such as "FUEL LOW", "ON", "OFF", etc.

Let the Dialco engineering department assist you in selecting the *right* lamp and the *most suitable* pilot light for your needs.

Dialco offers the *complete* line of pilot lights, from sub-miniature types to giant units with 1½" lenses.

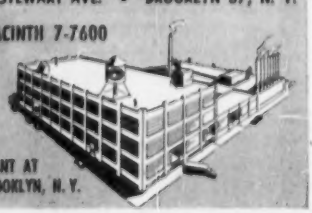
Every assembly is available complete with lamp.

SAMPLES ON REQUEST AT ONCE — NO CHARGE

Illustrations are approx. 70% actual size . . . *(A)* No. 8-1930-111 sub-miniature pilot light . . . *(B)* No. 521308-991, with multivue cap . . . *(C)* No. 922210-111, dimmer type . . . *(D)* No. 47901 with light shield cap.

Write for latest catalogues and Design Brochure.

Foremost Manufacturer of Pilot Lights
DIALIGHT
CORPORATION
60 STEWART AVE. • BROOKLYN 37, N. Y.
HYACINTH 7-7600



Want more information? Use post card on last page.

masses, structure, reactions, fission and spin, particle accelerators, cosmic rays and subnuclear particles.

Chapter II presents the more elementary concepts of quantum mechanics with more detailed material in the appendix. The quantum mechanical approach is used in presenting subsequent material.

▶ **Electronics**—The chapter on particle detection describes the operation of several electronic instruments including cloud chambers, electroscopes, scintillation counters, amplifiers, scalers and coincidence detectors. Also described are proportional counters and the mass spectrometer.

Under the heading of accelerators the reader can discover the principles of electrostatic generators, linear accelerators, cyclotrons, bevatrons and proton synchrotrons.

Other sections of the book treat electronic instrumentation used in nuclear experimentation such as the pair spectrometer for gamma-ray energies, the beta-ray spectrometer, molecular-beam magnetic resonance apparatus and r-f equipment for studying nuclear spin. Also covered are eletronic equipments for studying nuclear reactions, cosmic rays and subnuclear particles.—J.M.C.

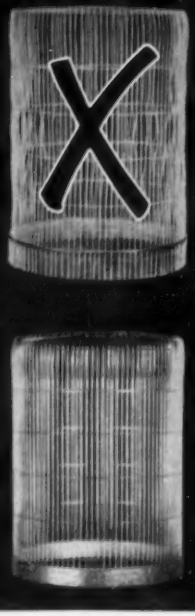
Thumbnail Reviews

Partial Differential Equations of Mathematical Physics. A. G. Webster. Dover Publications, Inc., New York, 1955, 440 p, $1.98 (paper). Reprint edition of 1927 work. Covers fields of mathematics particularly useful in electromagnetic studies.

ASTM Standards on Plastics. American Society for Testing Materials, Philadelphia, Pa., 1955, 790 p, $5.75 (paper). Presents specifications, methods for testing including electrical tests, recommended practices and definition of terms relating to many materials in wide use in the electronics industry.

Peaceful Uses of Atomic Energy, Vol. III, Power Reactors. Columbia University Press, New York, 1955, 389 p, $7.50. Proceedings of international conference held at Geneva in August 1955. This volume contains informa-

1200°C
PROVED IT CONCLUSIVELY!



NEW
BAKER
NON-SAG
Platinum Clad Tungsten Wire

STANDS UP BEST WHERE HIGH TEMPERATURES ARE REQUIRED!

In scientifically controlled comparison tests to determine relative sag at elevated temperatures, both platinum clad molybdenum and platinum clad tungsten wire showed very little sag. But at 1200°C the molybdenum sagged seven times faster than the tungsten.

In addition to this advantage, tungsten shows a substantially lower degree of interaction with platinum. Baker's Platinum Clad Tungsten Wire is available in a broad range of diameters.

Send for free booklet "Platinum Clad Tungsten Wire."

BAKER PRECIOUS METALS
A COMPANY OF ENGELHARD INDUSTRIES, INC.
113 ASTOR STREET, NEWARK 5, N. J.
NEW YORK • CHICAGO
SAN FRANCISCO • LOS ANGELES
ENGELHARD INDUSTRIES

Want more information? Use post card on last page.

tion on every central-station power reactor throughout the world. Discussion of many of the reactors includes material on instrumentation.

Table of the Descending Exponential. National Bureau of Standards. Superintendent of Documents, Washington, D. C., 76 p, $.50 (paper). Useful in applied electronic physics. Table extends from $x = 2.5$ to 10 at intervals of 0.001 to 20 decimal places.

Table of Hyperbolic Sines and Cosines. National Bureau of Standards. Superintendent of Documents, Washington, D. C., 81 p, $.55 (paper). Covers from $x = 2$ to 10 at intervals of 0.001 to nine significant figures.

Bulletin of the Academy of Sciences of the USSR. Columbia Technical Translations, White Plains, New York, single issues: $20; annual subscription: $110. Present copy, No. 3, Vol. 18, 1954 is 112 p, paperbound. It includes fifteen papers dealing with properties of ferrites. For example: Rotation of the Plane of Polarization of Centimeter Waves By a Ferrite Disk.

Broadcasting Stations of the World. Foreign Broadcast Information Service. Superintendent of Documents, Washington, D. C. (paper). Lists all known radio and television broadcasting stations except domestic stations within continental U. S. Published in four parts: Part I ($1.25) indexes stations according to country and city; Part II ($1.25) indexes according to frequency; Part III ($1.00) indexes by call letters or slogan; Part IV ($.60) deals with f-m and tv stations.

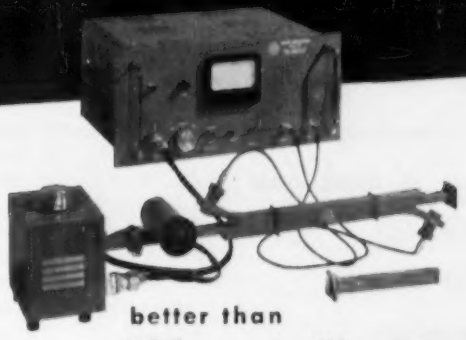
The Mathematical Analysis of Electrical and Optical Wave Motion. H. Bateman. Dover Publications, New York, 1955, 168 p, $1.60 (paper). Reprint of 1914 book on mathematical analysis of electromagnetic wave phenomena using Maxwell's equations.

Arbeitsverfahren und Stoffkunde der Hocvakuumtechnik Technologie der Elektronenrochren. H. Steyskal. Physik Verlag, Mosbach, Germany, 1955, 183 p, DM 14.40 (paper). Characteristics of materials and techniques used in the fabrication of electron tubes.

Techniques for Application of Electron Tubes in Military Equipment. Rex S. Whitlock. Office of Technical Services, Washington, D. C., 1955, 271 p (paper). Air Force technical report presents data on electron tubes intended for military applications. Gives essential tube properties and relates them to circuit design. Bulk of book consists of numerical data and design considerations for specific tube types.

CONTINUOUS, DIRECT-READING

X-BAND VSWR MEASUREMENT



better than

2% overall accuracy!

For speedy and accurate VSWR measurements in laboratory or production use, the CTI Model 1108 Measuring System reads directly, is continuously tunable from 8,500 to 9,600 mc.

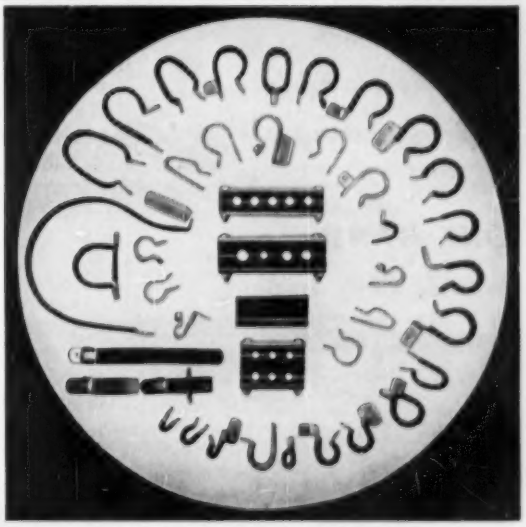
SPECIFICATIONS

Two VSWR Ranges:	1.02 to 1.2; 1.2 to 2.5
Attenuation Scale:	0 to ∞; 1.5 db midscale
Waveguide Fitting	UG-39/U
Directional Couplers, directivity	over 40 db

COLOR TELEVISION INCORPORATED

SAN CARLOS 1, CALIFORNIA

Cost Saving Ideas...



15,000 different types and sizes of LINE SUPPORT CLIPS, LINE SUPPORT BLOCKS and HARNESS STRAPS for positive, vibration-free support in aircraft, marine and industrial installations.

Consider the advantages of standardization — completeness of line — a smaller and more flexible inventory — quick and easy training of personnel — safety — durability — interchangeability — ECONOMY ... Specify ADEL

Complete Catalog available upon request

ADEL PRECISION PRODUCTS
A Division Of General Metals Corporation

Direct inquiries to Huntington Division
1444 Washington Avenue
Huntington 4, West Virginia

Burbank, California

Canada: Railway & Power Engineering Corporation, Limited

Want more information? Use post card on last page.

In winding Toroids on a BOESCH *machine a finished coil can be removed and a new one inserted ready for winding in the time it took you to read this far. No need to remove shuttle or other parts.*

CALL YOUR BOESCH REPRESENTATIVE TO SHOW YOU THE REST OF THIS PICTURE

ONE LEVER *controls clamping and spreading of shuttle -*

ONE HAND *inserts core and removes finished coil.*

Write today for complete information on BOESCH *winding machines*

BOESCH
MANUFACTURING CO., INC.
DANBURY, CONN.

Backtalk

Tubes Plus Diodes

DEAR SIRS:
CONCERNING the circuit shown on page 192 of Nov. ELECTRONICS ("Electronic D-C Amplifiers", by I. Barditch), no apparent purpose is served by the diodes in series with the plates of the 12AT7. The diodes present a high impedance to reversal of current, but the tubes already possess an infinite impedance to reversal of current, so the diodes appear to be superfluous.

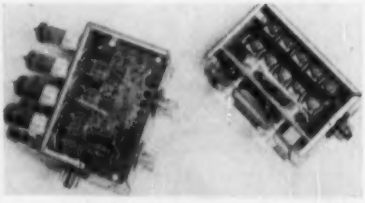
ROBERT HEPPE
Nutley, New Jersey

DEAR SIRS:
MR. HEPPE is probably not aware that tubes subjected to a high negative voltage on the plate exhibit a phenomenon known as "back emission". This is fully discussed in a Sylvania Engineering Information pamphlet Vol. I, No. 10, May 1954 in an article entitled "Effects of AC Plate Voltages on Tube Performance". It is pointed out therein that back emission can vary with temperature and from tube to tube, so that different tubes will perform differently in the same circuit.

The diodes prevent this from occurring. So, while it is possible the diodes can be omitted for economy, they do provide a measure of "design margin" that is desirable.

IRVING BARDITCH
Baltimore, Maryland

Magnetic Amplifier For Counters



Two decimal counting units shown in the photograph use tubes (left) and ferristors (right). Reduced size results from using a 50-year old principle in development of a modified magnetic amplifier (Electronics, p 128, Oct. 1955). The particular application is that of Beckman Instruments, Inc.

For consistently high purity...

"LINDE" M.S.C. RARE GASES
Trade-Mark
(Mass Spectrometer Controlled)

- Helium
- Argon
- Neon
- Krypton
- Xenon

In radar electronic equipment, nuclear radiation counters, cosmic ray cloud chambers, and thyratrons, where the purest rare gases are demanded, LINDE M.S.C. Grade gases meet the specifications. They are produced under continuous mass spectrometer control to assure you of gases of *known* purity and consistently high quality. LINDE, the world's largest producer of gases from the atmosphere, can meet your individual needs of volume, mixture, and container.

For information on the physical, chemical, and electrical properties of these gases, send for the booklet, "LINDE Rare Gases."

*

LINDE AIR PRODUCTS COMPANY
A Division of
Union Carbide and Carbon Corporation
30 E. 42nd Street UCC New York 17, N.Y.
In Canada:
LINDE AIR PRODUCTS COMPANY, Division of Union Carbide Canada Limited, Toronto
The term "Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.

Beattie
INTERVALOMETER
Model N-10

A Standard Method Of Supplying Operating Pulses For Flight-Test Instrumentation

The Model N-10 Intervalometer is a lightweight, compact instrument for controlling the cycle rate of camera recording devices and other electrically or electronically operated apparatus. Pulse rates per second are 1, 2, 4, 5, 8, and 10, and the pulse length is variable from 25 milliseconds to 70 milliseconds. Special pulse intervals and pulse duration may be supplied on order. The Model N-10 Intervalometer is built to meet *all* environmental conditions encountered in aircraft use.

Write for complete detailed specifications today

Photographic Products Inc.
1000 North Olive St. Anaheim, Calif.

PROFESSIONAL SERVICES

Consulting—Patents—Design—Development—Measurement

in

Radio, Audio, Industrial Electronic Appliances

ATLANTIC ELECTRONICS LABORATORIES

Design Development Prototypes

Specialists in
ELECTRONIC TIMING DEVICES

606 Bond St. Asbury Park, New Jersey

H. O. BIXBY ASSOCIATES

Consultants to the Electronic Industry

SURVEYS — PROMOTIONS — LIAISON
PERSONNEL PLACEMENT — TECHNOLOGY

238 Main St. Cambridge 42, Mass.
ELiot 4-0464

CROSBY LABORATORIES, INC.

Murray G. Crosby & Staff

Radio - Electronics
Research Development & Manufacturing
Communication, FM & TV

Robbins Lane, Hicksville, N. Y.
WElls 1-3191

DELAWARE PRODUCTS CO.

Analog Voltage to Digital Conversion
Digital Voltage Recording Systems

Design-Development-Manufacturing

300 Broadway Camden 3, N. J.

Eldico of New York, Inc.

Pioneers of Television Interference Elimination from Transmitters, Induction Heaters, Diathermy and etc.

Donald J. S. Morton & Engineering Staff

12 E. Second St. Mineola, L. I., N. Y.
Pioneer 6-5212

ELECTRONIC RESEARCH ASSOCIATES, INC.

"TRANSISTORIZE" YOUR PRODUCT!
Complete Service in consulting, research, development, and production on Transistor circuitry, products and instrumentation.

67 East Centre Street Nutley, N. J.
NUtley 2-5410

ERCO RADIO LABORATORIES, INC.

Radio Communications Equipment

Engineering - Design - Development - Production
Our 27th Year in Air to Ground
Communications and Radio Beacons

Garden City • Long Island • New York

HANSON-GORRILL-BRIAN INC.

Product & Mfg. Development

ELECTRICAL - ELECTRONIC
HYDRAULIC - MECHANICAL

One Continental Hill Glen Cove, N. Y.
Glen Cove 4-7200

WHEN TIME IS SHORT . . .

put the solution of your problems up to a specialized Consultant whose professional card appears on this page. His broad experience may save you months of costly experimentation.

ELECTRONICS
330 West 42nd St., New York 36, N. Y.

THE KULJIAN CORPORATION

ELECTRONICS DIVISION

Consulting Electronic Engineers

Research Development, Production of
Automatic Controls — Special Instrumentation

1200 No. Broad St., Philadelphia 21, Pa.
Stevenson 2-9000

Measurements Corporation

Research & Manufacturing Engineers

HARRY W. HOUCK MARTIAL A. HONNELL
JOHN M. VAN BEUREN

Specialists in the Design and
Development of Electronic Test Instruments

Boonton, New Jersey

MINOT INFORMATIC DEVICES

AUTOMATIC RECOGNITION OF
SHAPES, PATTERNS & INFORMATION
RESEARCH - INVENTION - CONSULTING
on detection and interpretation of complicated forms, characteristics of materials, printed characters, etc.

Otis N. Minot, 23 Eliot Rd., Lexington 73, Mass.
Tel. VOlunteer 2-9465 or -3974

DR. HAROLD NARCUS

Consultant

METALLIZING NON-CONDUCTORS

Pioneer in the field of metallizing non-conductors such as plastics, ceramics, glass, etc. for both industrial and decorative applications. Techniques and processes developed during 20 years specialization in the field. Recognized authority with well-known record of achievement.

Tel. PLeasant 3-5918
15 Vesper Street Worcester 2, Mass.

NIAGARA ELECTRON LABORATORIES

CONSULTATION - DESIGN - CONSTRUCTION
MFG. THE THERMOCAP RELAY

Specializing in solution of problems of electronic and electro-physical instrumentation for the research or analytical laboratory. Industrial plant problems also invited.

Andover, New York Cable Address: NITRONLAB

NUCLEAR-ELECTRONICS CORPORATION

From Engineering Design to the Finished Product
Specialists in
Nuclear Instrumentation—Communications
Test and Measuring Equipment
Industrial Electronics—Audio Equipment

2632-36 W. Cumberland St. Philadelphia, Pa.

PICKARD & BURNS, INC.

Consulting Electronic Engineers

Analysis and Evaluation
of Radio Systems

Research Development and Production
of Special Electronic Equipment

240 Highland Ave. Needham 94, Mass.

ALBERT PREISMAN

Consulting Engineer

Television, Pulse Technique, Video
Amplifiers, Phasing Networks
Industrial Appliances
Affiliated with
MANAGEMENT-TRAINING ASSOCIATES

2324 - 16th St., N. W. Washington 10, D. C.

SUNSTEIN ENGINEERING CO.

David H. Sunstein and Associates

Consulting Services for Research, Engineering and Production of Industrial, Consumer, and Government Products.

464 Conshohocken State Road
Bala-Cynwood (Phila.) Pa.
MOhawk 4-0459

THE TECHNICAL MATERIAL CORPORATION

Communications Consultants

Systems Engineering
General Offices and Laboratory

700 Fenimore Rd., Mamaroneck, N. Y.

TELECHROME, INC.

Electronic Design Specialists

COLOR TELEVISION EQUIPMENT

Flying Spot Scanners, Color Synthesizers, Keyers, Monitors, Oscilloscopes and Related Apparatus
J. B. Popkin-Clurman, *Pres. & Ch. Engr.*

88 Merrick Rd. Amityville, L. I., N. Y.

WALSH ENGINEERING CO.

Design and Prototypes
of Electronic Apparatus

in which Transformers and Magnetic Components are especially important factors in Performance, Size, Weight and/or Cost

34 DeHart Place Elizabeth, N. J.
Elizabeth 2-7600

WHEELER LABORATORIES, INC.

Radio and Electronics
Consulting — Research — Development
R-F Circuits —Lines — Antennas
Microwave Components — Test Equipment
Harold A. Wheeler and Engineering Staff

Great Neck, N. Y. HUnter 2-7876

YARDNEY LABORATORIES

Research-Design-Development

Electro-Chemical Generators of Energy

40-46 Leonard Street Worth 6-2100
New York 13, N. Y.

CONTACTS
FOR THE FIELD OF ELECTRONICS

Inductive & Non-Inductive
Rheostats & Resistors
Toroidal Coil Winding Mach.
Taping Machines
Winding Machines
REX RHEOSTAT CO.

MICA
India • Brazil
BLOCKS • FILMS • SPLITTINGS
All Grades & Qualities—Warehouse Stocks
New York—Prompt Forward Shipments
Phone: WOrth 4-4192 or write
ASSOCIATED COMMODITY CORPORATION
Woolworth Bldg., New York 7, N. Y.

Wind Perfect Coils
Check Wire Tensions
with the New Saxl
TENSION METER
Tensitron, Inc., Harvard, Mass.

MANUFACTURERS' REPRESENTATIVES
IN THE ELECTRONIC INDUSTRY

As a service to readers, ELECTRONICS presents the advertisements for some of the leading manufacturers' representatives in the electronic industry. These firms are qualified to help the *Manufacturer* with his distribution problems; the *Buyer* with his product needs.

MARYLAND

MACLEN CORPORATION
Manufacturers Representative
8610 Georgia Ave, Silver Spring, Md
Components & Equipment
Territory: Pennsylvania New Jersey Delaware Maryland Virginia W. Virginia District of Columbia
Government and Industry

PENNSYLVANIA

SAMUEL K. MACDONALD, INC.
manufacturers representatives over 25 years
1531 SPRUCE STREET, PHILA. 2, PA.
Territory: Pennsylvania • New Jersey Delaware • Maryland Virginia • West Virginia District of Columbia
Other Offices: Pittsburgh Baltimore Washington, D.C.

REPRESENTATIVES!

This is a special section for Manufacturers' Representatives desiring advertising space in units smaller than the minimum run of book display space.

It offers you an economical means to keep in contact with the key people of the electronic industry who most naturally will be interested in your products and services as a source of supply or as a sales outlet for their products.

SPACE is available in units from one to four inches. A "one inch" space unit is an "advertising inch" measuring ⅞" deep by one column in width, 2¼". Larger space is by additional even lineal inch units in depth, or by additional columns in width, or both. Oversized advertisements are not accepted.

RATES: One insertion $26.50 per inch, Six insertions $24.00 per inch, Twelve insertions $22.00 per inch. Cash discount 2%—10th of month following date of invoice. 15% Agency Commission.

whatever your publication needs...

Equipment Manuals — Product Catalogs — Handbooks — Training Aids — Industrial Relations Literature — Procedural Guides — Engineering Presentations — — — and any type of technical literature

use our specialists in — — —
WRITING . . . EDITING
ILLUSTRATING . . . PRINTING

McGRAW-HILL
Technical Writing Service•
330 West 42nd St., N.Y.C. 36
LOngacre 4-3000

EMPLOYMENT OPPORTUNITIES

"SUCCESS breeds SUCCESS"

An old chestnut, perhaps — but still TRUE!

It is important to us, too, because this is why we continue to attract the best.

We lead the field because we have the best engineers . . . . the best engineers seek employment here because we lead the field.

It's as simple as that!
"Not quite"—you say? Then why not come in and talk it over?

Since many tube programs continue to expand, we require PhD's, Masters and Bachelors in EE, ME, Physics and Chemistry to fill openings as follows:

TRAVELING WAVE TUBE DEVELOPMENT—A recent addition, but we're fast gaining the necessary momentum to attain the lead.

MAGNETRON RESEARCH & DEVELOPMENT—Raytheon's leadership in this field was earned during World War II and is being increased now for both defense and industry.

CROSSED FIELD TUBE DEVELOPMENT—High & Low Power Backward Wave Tubes, as well as some you've never heard of.

PRODUCT ENGINEERING—Parlayed with our R.&D. you have an unbeatable combination.

APPLICATIONS ENGINEERING—The engineer who likes to travel couldn't make a better choice.

CATHODE RESEARCH & DEVELOPMENT—We need one man in this section and he must be outstanding.

METHODS & FACILITIES DEVELOPMENT—Four men were recently promoted from this group leaving the field wide open for the right men.

KLYSTRON ENGINEERING—A basic interesting part of the microwave tube field in which new developments appear constantly.

Please send complete resume of your qualifications and experience to Mr. D. Hamant at:

RAYTHEON MANUFACTURING COMPANY

Foundry Avenue

Waltham 54, Massachusetts

Excellence RAYTHEON *in Electronics*

EMPLOYMENT OPPORTUNITIES

Engineers

HOW INCREASED SYLVANIA SALES

HELP YOU AS AN ENGINEER

Sylvania has quadrupled its 1947 sales and is expanding rapidly. We plow back into research and engineering an unusually high percentage of each year's income; it rates with the highest figures in industry today. These increases make for a broader based engineering while adding engineering management...creating unusual opportunities for men of talent.

At the base are recent college graduates with little or no experience. Filling in the essential positions of research direction, supervision and testing are engineers with experience and proven ability in their specialized fields.

Increasing our overall research constantly creates openings. These openings lead eventually to far greater responsibility either in engineering management or research specialties. Top engineers are key men in creating new and better products that open new markets to Sylvania.

There are openings now for experienced men at Sylvania.

WALTHAM Laboratories

Majors in E.E., M.E., Math, Physics. Research & Development experience in—

Avionics

- Countermeasures
- Systems Analysis
- Transistor Applications
- Noise Studies
- Antenna Res. & Dev.
- Systems Development
- Mechanical Design
- Miniaturization
- Digital Computer Circuits & Systems
- Circuit Designs
- Shock & Vibration
- Technical Writing
- Missile Analysis

Missile Systems

- Radar Research & Development
- Missile Guidance & Ground Equipment Analysis
- Systems Evaluation Operations Research

BUFFALO Engineering Laboratory

Majors in E.E., Math or Physics. Experience in Advanced Development and Product Design

- Information Theory
- Advanced Circuit Design
- VHF-UHF Systems Design & Evaluation
- Logical Circuit Design
- Mathematical Analysis and/or Numerical Computation
- Pulse Techniques
- Data Processing Devices
- Magnetic Amplifier Techniques
- Servo Techniques & Applications
- Digital Computer Design
- Control Circuits & Devices

INTERVIEW & RELOCATION EXPENSES WILL BE PAID BY SYLVANIA

Sylvania provides financial support for advanced education as well as liberal insurance, pension and medical programs.

Please forward resume to: Professional Placement Supervisor

Erling Mostue | E. F. Culverhouse
100 First Ave. | 175 Great Arrow Ave.
Waltham, Mass. | Buffalo 7, N. Y.

Your inquiries will be answered within 2 weeks

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.

ELECTRONIC ENGINEERS

RESEARCH DEVELOPMENT

Expansion of our engineering department requires electronic engineers with radar, servo, sonar or transistor circuit experience. Excellent opportunity for advancement with top-calibre associates. New modern plant in the suburbs with ideal laboratory facilities and well-trained technical assistants.

Other Opportunities in the following areas:

- **TECHNICAL WRITERS**
- **DRAFTING** Electrical Layout
- **DETAILING** Electrical - Mechanical

DESIGN ENGINEERS

Must have EE degree or equivalent, with 3-5 years experience in one of the following:

— Flight Simulators
— Analog Computers
— Radar & Sonar Trainers
— Radar Guidance & Fire Control Systems
— Redesign, Modification & Testing of Radar & Electronic Systems
— Electronic Installation & Maintenance
— Coil & Transformer Design
— Packaged Power Supplies

Other Openings For:

COMMUNICATIONS EQUIPMENT DESIGNERS

COMPUTER DESIGNERS

AERODYNAMICISTS

(*) Other challenging openings in the fields of: Human Engineering, Mathematics, Missile Guidance Systems and Low-Frequency vibration studies.

LOCATION:
On U. S. Highway 22, thirty miles (45 minutes) from New York City.

ENVIRONMENT:
One of the finest plants of its kind . . . spacious, modern, air-conditioned. Conducive to bringing out the best of your abilities!

ABOUT THE COMPANY:
Organized in 1945. Engaged in research, design and development for the Armed Services.

ITS BENEFITS:

- Pension Plan
- Group Life Insurance
- Paid Holidays
- Paid Sick Leave
- Paid Vacations
- Education & Tuition Assistance
- Other Group Insurances

Interviews in Your Community by Appointment

Send resume, write or call for additional information.

STAVID ENGINEERING
Incorporated
45 MINUTES FROM NEW YORK CITY
U. S. Highway 22
Watchung, P. O.
Plainfield, N. J.
Plainfield 7-1600

EMPLOYMENT OPPORTUNITIES

How much is an idea worth..?

Plenty, if it's given a chance. In the hands of a creative engineer, a promising idea is the first step toward significant achievement. But before it pays off, it must be transformed into a reality.

That's the way we work at Goodyear Aircraft. Here, ideas are a prime commodity—they are our raw materials. And to make them work, our engineers have the most modern facilities available, including one of the largest computer laboratories in the world. Here, every idea gets a chance to mature.

This respect for individual thought and effort has been a key factor in our many great contributions to aeronautics. During the past 46 years, in peace and in war, our engineers have turned ideas into accomplishments that, today, are a part of nearly every aircraft in our skies. Airships, structural materials, electronic equipment, reinforced structural plastics, missile components – the list is long and broad. And tomorrow – who knows – maybe *your* idea will be added to the impressive list.

For if you have faith in your ideas and your ability to make them work, this may well be the challenge you have been seeking. Our continued growth and diversification demand expansion of our creative engineering staff. Opportunities are unlimited at both Akron, Ohio, and Litchfield Park, Arizona, for rewarding professional careers in all specialties of engineering.

Salaries and benefits are, of course, liberal. And for those who wish to continue with academic studies, company-paid tuition courses leading to advanced degrees have been established at nearby colleges. For further information on *your* career opportunities at Goodyear Aircraft, write: Mr. C. G. Jones, Personnel Department, Goodyear Aircraft Corporation, Akron 15, Ohio.

They're doing big things at

GOODYEAR AIRCRAFT

THE TEAM TO TEAM WITH IN AERONAUTICS

Fort Wayne, Ind.
"America's Happiest City"

Dear Bill:

Now that Joe is on the team here at Farnsworth, he's asked me to write and give you the same story that got him interested in coming with us.

Actually, Bill, it wasn't a "story." Just a few honest-to-goodness reasons why he and Marge should make the move and let the family really live as well as let Joe grow professionally.

For instance, do you know what "sold" Marge? The fact that in living here you are only 10 minutes from everywhere—schools, churches, stores etc. and Joe goes home for lunch every day instead of week-ends. She also liked the idea of some 300 lakes within 70 miles. (Guess where they're planning to spend the summer!)

As for Joe, he's all hepped up about the work he's doing on such missiles as Bomarc, Talos, Terrier and others. Says the top-notch scientists and engineers he's working with are all big league and he's on the team.

That's about it, Bill. An engineer with your talents shouldn't be waiting around when he can get in on the ground floor here at Farnsworth in research, development or production engineering in missile guidance and control, radar, microwaves, test equipment, countermeasures, transistor applications etc.

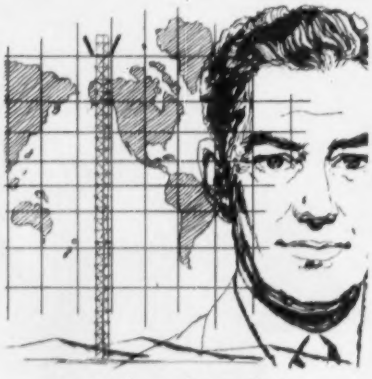
So—why not write, right now to Don Dionne, Farnsworth Electronics Co. Fort Wayne, Ind. (A division of International Telephone and Telegraph Corp.)

You, Joe, I and Farnsworth will be mighty glad you did.

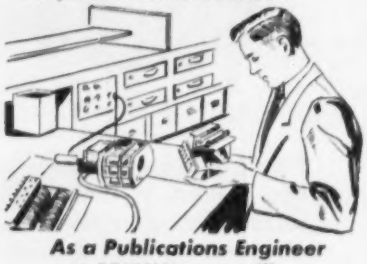
Sincerely, Jack

Electronics engineers

do you see...
the over-all picture...



or just the details?



As a Publications Engineer at COLLINS you will...

1. work with the creative leader in the electronics field,
2. write engineering reports on over-all projects, including some of the most advanced electronic work in the industry.
3. write on complete systems, their operation, installation, theory and test.

COLLINS offers outstanding opportunities for electronics engineers in the field of technical writing on:

MICROWAVE RELAY	FLIGHT CONTROL
NAVIGATION SYSTEMS	RADAR SYSTEMS
COMMUNICATIONS SYSTEMS	GUIDED MISSILES
SSB SYSTEMS	COMPUTERS
RADIO ASTRONOMY	AMATEUR EQUIPMENT

...plus top salaries, opportunity for advancement, company sponsored life, accident, sickness and hospitalization insurance, retirement plan and liberal moving expense allowance.

Electrical Engineers or Physics Majors with good electronic background and an aptitude for writing are desired. Actual writing experience is not necessary.

OPENINGS IN CEDAR RAPIDS, IOWA, BURBANK, CALIF. AND DALLAS, TEXAS

Send Resume to: **MR. L. R. NUSS**

COLLINS RADIO COMPANY
CEDAR RAPIDS, IOWA

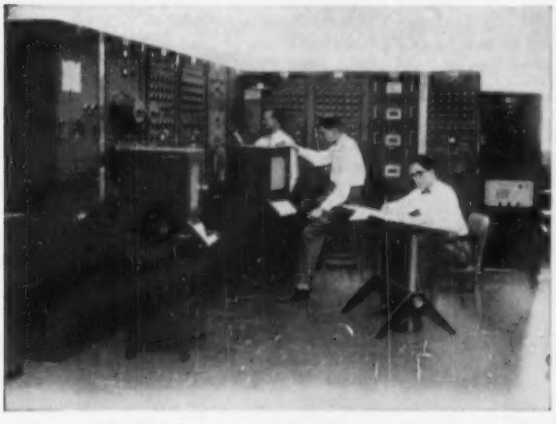
EMPLOYMENT OPPORTUNITIES

Bendix GUIDED MISSILES

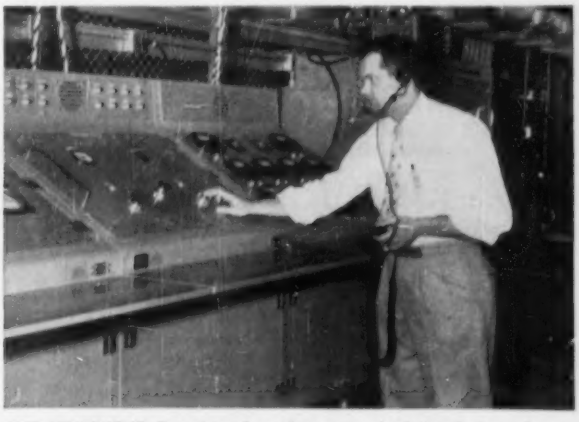
offer interesting jobs with outstanding futures

MISSILE SYSTEMS TESTING—In Missile Systems Testing, opportunities exist in two areas; First, as part of the teams that test newly developed experimental missiles; and second, for those with a good technical background and a penchant for dealing with production problems as a technical supervisor in our final test organization.

MISSILE GUIDANCE—Engineers are needed to design, develop and test prototype systems of an extremely complex missile system. Experience in microwaves, electronics, mechanics, servo systems and related fields is essential.



SYSTEMS ANALYSIS—Engineers are needed to work on fundamental problems of analytical dynamics in over-all behavior of missiles and weapons systems and the interactions of components and systems of a missile, particularly in terms of weapons performance. Ability, training and experience in analogue and digital computers, breadboards, prototypes of missile equipment, and electronic and mechanical simulators are essential in these positions.



TEST EQUIPMENT—Experienced engineers required for design of precision electronic and electro-mechanical automatic test equipment and instrumentation. Programming, signal generation from low frequency to microwave, analogue and digital data handling, and go-no-go comparators and indicators are involved.

Bendix Guided Missiles also offer interesting job opportunities for Senior Engineers, Assistant Engineers, Junior Engineers and Technicians.

A thirty-six-page book, "Your Future in Guided Missiles", describing in detail the many phases of our guided-missile operation and the job opportunities available to you, will be sent to you on request. Write for your copy today.—BENDIX PRODUCTS DIVISION—MISSILES—403B Bendix Drive, South Bend, Ind.

MEN OF VISION

Apply your creative engineering to research, development and design . . .

THE KEY TO YOUR SOLID SUCCESS AT

Admiral®

These positions are tailor-made for highly imaginative engineers who like problems of more than average difficulty; assignments that require a maximum of individual electronic creativeness.

CURRENT OPENINGS INCLUDE:

RADAR AND PULSE SYSTEMS

Background of VHF-UHF development including circuitry design for air-borne and ground equipment. Long term development involves application of interesting new techniques.

DEFLECTION CIRCUIT ENGINEERS

To do original work on the design and development of horizontal and vertical deflection components and circuitry for both monochrome and color receivers.

PHYSICISTS—ENGINEERS

Experienced in measuring and evaluating reactor fields—neutron and gamma measurements, calculation of effects of these fields on electronic components.

COMPONENT PARTS

Long terms projects on the design of television components with emphasis on engineering control of yokes, tuners and flyback transformers in production.

COMMUNICATION SYSTEMS

For design of complex systems. Familiarity with air-borne receivers and transmitters required. Knowledge of transistor theory and application to military equipment an asset.

ENGINEERING WRITERS

To organize, write and edit operating and maintenance manuals. Openings also available for compiling technical disertations used for government bid proposals.

RECENT GRADUATES OR EXPERIENCED MEN

This is an invitation to *both* of you to inquire about these and other opportunities.

Liberal salaries based on education, ability and experience. Paid life insurance and hospitalization plus a retirement plan, liberal vacation policy and periodic salary reviews are added benefits.

If you are interested in a secure future, write and give full details to Mr. W. A. Wecker, Personnel Division.

Admiral Corporation

3800 W. Cortland St. • Chicago 47, Illinois

Needed Now...

Engineering Talent

in ■ Electronics

■ Physics

■ Mechanics

IRL

Here's a Career with a Future!

Here is a *career* opportunity for you to associate yourself with a rapidly growing organization. Industrial Research Laboratories is located in suburban Baltimore and is housed in buildings that were designed to be research laboratories. The organization is large enough to handle complex systems problems, yet small enough to insure individual recognition. Personnel are associated with all phases of projects to which they are assigned and have the advantage of participating in the entire project, not just a segment of it.

Industrial Research Laboratories has a liberal approach to vacations, sick leaves and incentive plans, and offers many additional benefits.

Our production and earning curves have been constantly on the upswing since our inception, and we have never discharged or furloughed an employee for lack of work.

If you are interested in a *career* with future, *write:*

INDUSTRIAL RESEARCH LABORATORIES IRL

Div. of Aeronca Manufacturing Corp.

Dept. A-4, Hilltop & Frederick Rds.

Baltimore 28, Maryland

ENGINEERS

Honeywell

"First In Controls"

OFFERS EXCELLENT OPPORTUNITIES IN

NUCLEAR ENGINEERING

PROJECT

. . . with nuclear science background. Position requires interest and ability in the design of control systems. Employment with HONEYWELL offers broad opportunities in the nuclear field.

RESEARCH

. . . including analysis of electronic controls and control systems, using control theory and analog tests. Variety of other applied research activities.

DEVELOPMENT

. . . of electronic and electromechanical devices for detection and control of all types of industrial process variables.

. . . development and design of complex industrial instrumentation systems, data reduction and data handling systems.

. . . development of pneumatic and mechanical devices for flow measurement and control and other small electromechanical controls and recording instruments.

APPLICATION

. . . personal contact with customers, determining exact needs for custom-built devices or systems, determine feasibility of maufacturing special products by estimating engineering time necessary, etc.

CONTACT OUR REPRESENTATIVE
MR. D. R. GARVEY

HONEYWELL
BROWN INSTRUMENTS
Wayne & Windrim Aves.
Philadelphia 44, Pa.

SEMICONDUCTOR ENGINEERS and SCIENTISTS

RAYTHEON

Unusual long range opportunities are available due to our current expansion and past record of performance.

Raytheon, one of the world's largest producers, has already shipped over 15 million semiconductor devices. Raytheon is the only volume producer of the complete line of silicon power rectifiers, and both germanium and silicon transistors and diodes.

The newly created **SEMICONDUCTOR DIVISION** is now rapidly expanding in a separate plant with 3 acres of floor space; 9 acres of land are available for planned future expansion. This location provides small-company atmosphere for professional growth and opportunity with large company resources and stability. The plant is within 6 miles of Greater Boston's six leading universities and colleges; Raytheon's tuition refund plan encourages advanced study.

ELECTRONIC ENGINEERS

BS or MS in EE for development evaluation, and pilot line positions. Semi-conductor experience valuable.

PHYSICISTS

BS, MS or PhD. To participate in theoretical analyses and device development. Transistor or Diode experience valuable. Knowledge of solid state principles desired.

METALLURGISTS

BS or MS. Knowledge of crystal growing, electronics of crystals. Transistor or Diode experience desired but not essential.

APPLICATIONS ENGINEERS

Cuircuitry Involving applications of transistors in missile and other airborne electronics, computers, communications equipment and hearing aids.

Engineering Section Leader—extensive experience in customer contact at engineering level, and supervision of circuit engineers working on transistor applications problems.

PRODUCT ENGINEERS

BS or MS in Chemistry, Metallurgy, Physics or Electrical Engineering. Specify and control semiconductor production processes.

MECHANICAL ENGINEERS AND AUTOMATIC MACHINE DESIGNERS

BS or MS or equivalent experience. Experience in mechanisms as applied to automatic machinery for small parts. Knowledge of materials and small parts fabrication techniques valuable.

SALES ENGINEERS

BS, MS or EE or equivalent experience. Customer contact at engineering level. Electronic component experience necessary.

Please send complete resume to:

Vaughan Andrews, Technical Placement Office

RAYTHEON

SEMICONDUCTOR DIVISION

150 California St., Newton 58, Mass.

Excellence in Electronics

You can SELECT at RCA!

...New Opportunities...17 + Locations...One Best For You And Your Family

Can anyone but RCA offer you a choice of locations like this?
At Camden, Moorestown or Cherry Hill, you enjoy cultural advantages of Greater Philadelphia, live at moderate cost in pleasant suburban communities. Waltham offers at-home opportunities for New England engineers. Four ideal West Coast locations. Harrison borders on Greater New York. Lancaster, Marion and Findlay have small-town advantages. There's pleasant year-round outdoor living in Cocoa Beach, on Florida's central east coast. RCA Service Company and International Division assignments include ideal locations in the United States, and wherever RCA electronic equipments are installed and serviced throughout the world.

Individual Recognition—
RCA organizes engineering activities into groups small enough to allow broadest scope for your individual accomplishment. The average group has just 11 engineers. Yet, in all activities, you are supported by the entire facilities and engineering resources of RCA.

Salaries—
RCA engineering salaries average measurably higher than other companies' in the field. Intermediate engineers, $5000-$8500; senior engineers, $8500-$15,000; staff and supervisory salaries open.

Advancement—
Scheduled, objective appraisal of your work speeds promotion. Professional and financial progress is just as sure as your achievements make it.

Professional Status—
RCA bases world leadership in electronics on the abilities of exceptional men at every organizational level. Many have notable engineering and scientific reputations. You work in day-by-day association with men of this caliber.

Benefits—
There's a complete program at RCA. A very liberal Tuition Refund Plan. Company-paid life, sickness and accident, hospital-surgical insurance for you and your family. Modern retirement plan. Relocation expenses paid. Suggestion and patent awards.

Now, Pinpoint Your Future

...Here are the Opportunities!
...Here are the Locations!

FIELDS OF ENGINEERING ACTIVITY		MANAGERS	TYPE OF DEGREE AND YEARS OF EXPERIENCE PREFERRED											
			Electrical Engineers			Mechanical Engineers			Physical Science			Chemistry Ceramics Glass Technology Metallurgy		
			0-2	2-3	4-15	0-2	2-3	4-15	1-2	2-3	4-15	1-2	2-3	4-15
• ***SYSTEMS*** *(Integration of theory, equipments and environment to create and optimize major electronic concepts.)*	AVIATION ELECTRONICS • CONTROLS			W	W M			M		W	W M			
	DIGITAL DATA HANDLING DEVICES	M C		M C	M C		C	C		C	C			
	MISSILE ELECTRONICS • RADAR	M W		M W X	M W X		M W	M W		M W	M W			
	INERTIAL NAVIGATION	W			W			W			W			
	COMMUNICATIONS			·	C						C			
• ***DESIGN • DEVELOPMENT*** **KINESCOPES (B & W and COLOR), OSCILLOSCOPES**—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photosensitive Materials and Glass to Metal Sealing)			L	L Y	L Y	L	L Y	L Y	L	L	L	L	L Y	L Y
RECEIVING TUBES—Tube Design—Test and Application Engineering—Chemical and Physical Development—Methods and Process Engineering—Advanced Development			H	H	H		H	H		H	H		H	H
SEMI-CONDUCTORS—Transistors—Semi-Conductor Devices—Materials			H	H	H	H	H	H	H	H	H	H	H	H
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave—Magnetron)		H		H	H		H	H		H	H		H	H
GAS, POWER AND PHOTO TUBES—Photosensitive Devices—Glass to Metal Sealing—UHF and VHF—Power			L	L	L	L	L	L	L	L	L	L	L	
AVIATION ELECTRONICS—Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Automation—Transistorization		W C	W C X	W C X	W C X	W C	W C X	W C X	W C X	W C X	W C X			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming			C	C X	M C X	C	C X	M C X	C	C	M C			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control—Information Handling—Displays		M C	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X			
COMMUNICATIONS—Specialized Military Systems—Microwave—Aviation—Audio—Propagation Studies			C	C	C		C	C	C	C	C			
MISSILE ELECTRONICS—Systems Planning and Design—Radar—Fire Control—Shock Problems—Servo Mechanisms		M	M X	M X	M X	M	M	M X	M	M X	M X			
COMPONENTS—Transformers—Coils—TV Deflection Yokes (Color or Monochrome)—Resistors—Ferrites (Material and Parts)			C	Z C	Z C	C	Z C	Z C	C	C	C		Z C	Z C
• ***SYSTEMS APPLICATION*** *(Evaluation and Planning—Design and Development—Modification—Specification)*														
MISSILE TEST INSTRUMENTATION (Data Acquisition and Processing)—Radar—Telemetry—Timing—Communications—Optics—Computers		F	F S	F S	F S	F S	F S	F S	F S	F S	F S			
RADAR—Airborne—Surface—Shipboard—Sonar—Fire Control		F	F S	F S	F S	F S	F S	F S	F S	F S	F S			
COMMUNICATIONS—Radio—HF—VHF—UHF—Microwave—Telephone—Teletype—Telegraph Terminal Equipment—Wave Propagation		F	F S I	F S I	F S I	F S	F S	F S	F S	F S	F S			
• ***MACHINE DESIGN*** Mechanical and Electrical—Automatic or Semi-Automatic Machines			L	L		L	L H Y	C H Y		L	L			

Locations: **C**—Camden, N.J. **F**—Cocoa Beach, Fla. **H**—Harrison, N.J. **I**—International Div. **L**—Lancaster, Pa. **M**—Moorestown, N.J. **S**—RCA Service Co. (Cherry Hill, N.J.; Alexandria, Va.; Tucson, Ariz.; San Diego, Sacramento, San Francisco, Calif.; Foreign Assignments). **W**—Waltham, Mass. **X**—Los Angeles, Calif. **Y**—Marion, Ind. **Z**—Findlay, Ohio

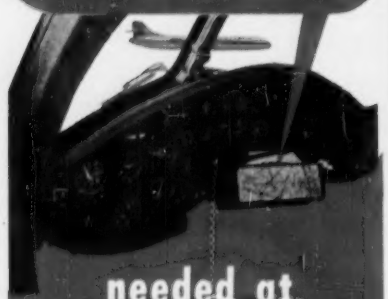
Please send resume of education and experience, with location preferred, to:

Mr. John R. Wald, Employment Manager
Dept. A-15D, Radio Corporation of America
30 Rockefeller Plaza, New York 20, N.Y.

RADIO CORPORATION of AMERICA

Copyright 1956 Radio Corporation of America

NAVIGATIONAL EQUIPMENT ENGINEERS



needed at Bendix in SOUTHERN CALIFORNIA

Engineers skilled in circuit design of electronic navigational equipment for aircraft are being offered excellent opportunities at Bendix-Pacific. These are secure, well paying positions with strong peace time application.

Bendix-Pacific also has unusual positions in electrical and mechanical design of airborne radar, telemetering and missile guidance.

Let us send you complete information. Mail the coupon or write us today.

W. C. Walker, Engineering Employment Manager
Pacific Division, Bendix Aviation Corp.
11608 Sherman Way, North Hollywood, Calif.

I am interested in
Navigational Equipment Engineering.

I am a graduate engineer with ____ degree.

I am not a graduate engineer but have ____ years experience.

Name ____

Address ____

City ____ Zone ____ State ____

Are You an Engineer Who wants to go Higher—Faster?

Aiming for the upper strata, but still earth-bound after a few years of ambition-blunted effort? Here's your chance to move just as far and as fast as your ability and hard work will justify.

We're offering careers—not jobs—in electronics, semiconductors and color TV with a company that's youthfully mature, yet growing and expanding every day.

Submit resume or address request for personal interview to D. Bellat, Personnel Director, Tung-Sol Electric Inc., 200 Bloomfield Avenue, Bloomfield, N. J.

TUNG-SOL®

EAST ORANGE • BLOOMFIELD, N. J.

Radio and TV Tubes

Aluminized Picture Tubes

Special Purpose Tubes

Semiconductors

Color Picture Tubes

TO THE FINE ENGINEERING MIND
SEEKING THE CHALLENGING PROJECTS IN

ELECTRONICS

ELECTRONICS ENGINEERS are urgently needed to fill top career openings at Convair in beautiful San Diego, California. Qualifications include experience in missile guidance systems, microwave techniques, digital computers, servomechanisms, test equipment design, circuit analysis, transistor and magnetic amplifier circuit design, and electronic reliability. Antenna engineers also needed for airborne antenna research and development projects.

CONVAIR offers you an imaginative, explorative, energetic engineering department... truly the "engineer's" engineering department to challenge your mind, your skills, your abilities in solving the complex problems of vital, new, long-range programs. You will find salaries, facilities, engineering policies, educational opportunities and personal advantages excellent.

SMOG-FREE SAN DIEGO, lovely, sunny city on the coast of Southern California, offers you and your family a wonderful, new way of life ... a way of life judged by most as the Nation's finest for climate, natural beauty and easy (indoor-outdoor) living. Housing is plentiful and reasonable.

Generous travel allowances to engineers who are accepted. Write at once enclosing full resume to: H. T. BROOKS, ENGINEERING PERSONNEL, DEPT. 916

CONVAIR

A Division of General Dynamics Corporation

3302 PACIFIC HIGHWAY · SAN DIEGO, CALIFORNIA

SYLVANIA'S

CALIFORNIA RESEARCH LABORATORY

(San Francisco Bay Area—Near Palo Alto)

Needs experienced creative engineers for a long range research and development program in microwave electronic systems and components. Also needs experts in design and custom packaging of specialized electronic communications equipment.

We have specific openings for ENGINEERING SPECIALISTS, SENIOR ENGINEERS and ENGINEERS in:

SYSTEMS ANALYSIS For weapons systems planning, operational analysis and data handling problems.

MICROWAVE ANTENNAS For investigation of new concepts in polarization and pattern control, direction finding and multi-function radiators.

MICROWAVE CIRCUITS For advancements in synthesis of filters, broadband mixers, power dividers, etc., involving modern techniques of stripline, ridge guide and periodic structures.

TRANSMITTER DEVELOPMENT For research and development involving microwaves and pulse techniques.

FIELD ENGINEERING For advanced engineering field tests of prototype equipment.

RECEIVER DEVELOPMENT For design and development of microwave and communications receivers and pulse circuitry.

Sylvania offers the finest facilities and equipment available. We also provide financial support for advanced education, as well as a liberal insurance, pension and medical program.

Our Laboratory is located 5 miles from Palo Alto in the San Francisco Bay area, close to excellent schools and universities, unexcelled living conditions, ideal climate and ample housing.

RELOCATION EXPENSES PAID

Please send complete resume to JOHN C. RICHARDS Electronic Defense Laboratory Box 205 Mountain View, California

All inquiries will be answered within two weeks.

ELECTRONIC DEFENSE LABORATORY

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.

ELECTRONIC ENGINEERS!

ARE YOU ENGINEERS . . . OR TIME CARD NUMBERS?

If you are tied up in red tape . . . if the scope of your work is limited . . . if you can't use your creative engineering abilities . . . then MEMCO offers you a sound escape from stagnation and monotony.

AT

MEMCO:

every electronic engineer...

- is encouraged to use his creative talents.
- works on all phases of his projects.
- is appreciated as an engineer, not as a replaceable cog in a big machine.
- gets top pay and the usual benefits.
- can build a sound, worthwhile future.

For full details please write to:

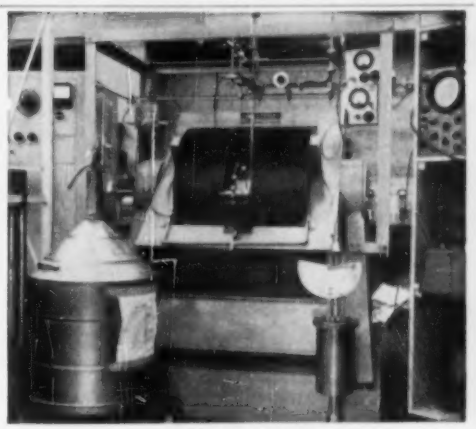
MARYLAND ELECTRONIC

MANUFACTURING CORPORATION

5009 Calvert Road
College Park, Maryland

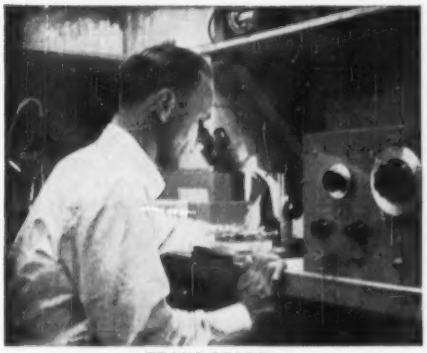
(A suburb of Washington, D. C.)

LOW TEMPERATURE

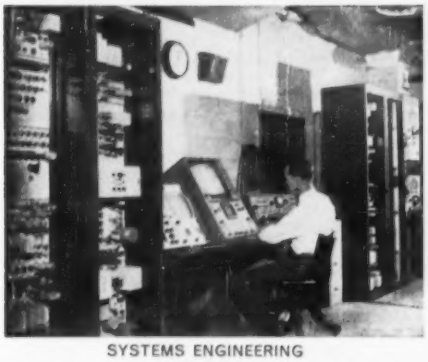


SPIN RESONANCE

ENGINEERS, PHYSICISTS, CHEMISTS



TRANSISTORS



SYSTEMS ENGINEERING

Zenith wants to talk to you about:

- **Solid State Physics**
- **Transistors**
- **Circuits for Color & Monochrome Television and Radio**
- **New Types of Vacuum Tubes**
- **Radio & TV Receiver Design**
- **Subscription TV (Phonevision)**
- **Ceramic Engineering (High Dielectric, Piezoelectric)**
- **Patents**
- **Industrial Engineering (Automation)**

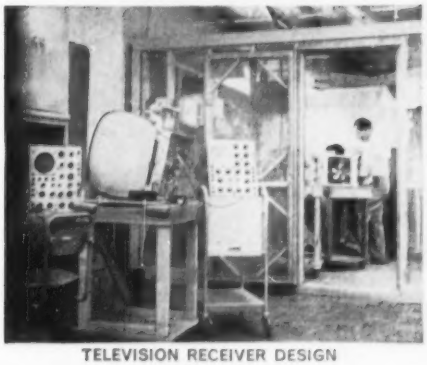
Modern Air-Conditioned Laboratories

Attractive Profit Sharing and Insurance Plans

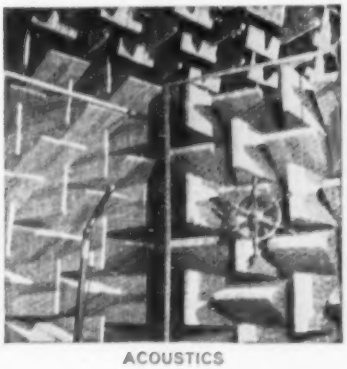
Outer Chicago Location with Opportunity for Suburban Living and Graduate Study

Non-Classified Work—Publication Encouraged

Since 1919 Zenith has manufactured radios for home use and is one of the country's oldest companies continuously in this field. It is today a leading manufacturer of quality television sets and hearing aids. Continuity of management, a record of pioneer technical developments and a reputation for quality products are important factors for you to consider. Zenith's consistent, steady growth and unusually low engineering turnover rate indicate a desirable combination of opportunity and stability.



TELEVISION RECEIVER DESIGN

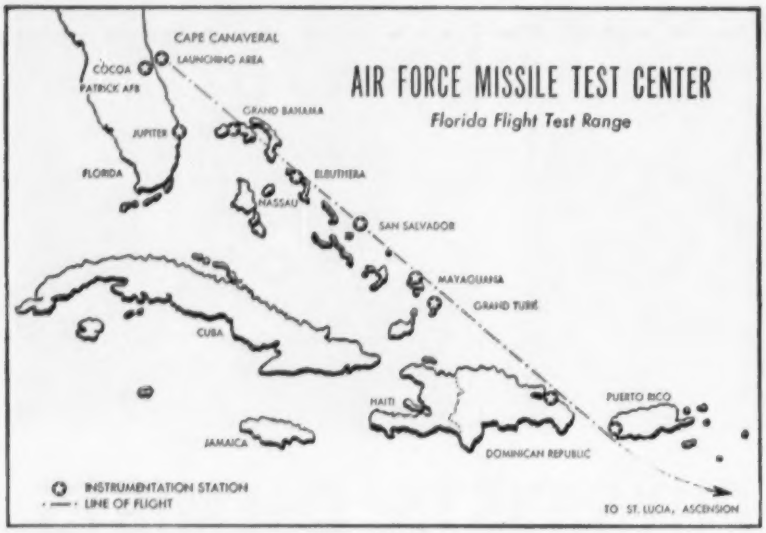


ACOUSTICS

For an appointment, write to
G. E. GUSTAFSON
Vice President, Engineering
Zenith Radio Corporation
6001 Dickens Avenue, Chicago 39, Illinois

ZENITH®

RADIO CORPORATION



Engineers and Scientists:

INSTRUMENTATION SYSTEMS ENGINEERING
for **MILITARY APPLICATIONS**

SALARIES UP TO $14,000.

IN THESE NEW PROGRAMS AT THE MISSILE TEST PROJECT, FLORIDA

Have you as an engineer or scientist considered the problems and projects associated with the instrumentation and control of a long range missile, guided over a course that extends thousands of miles?

To achieve precision performance, missile launching and guidance require a vast network of instrumentation and control. New development programs have created challenging opportunities for Electronics Engineers and Scientists who are interested in data acquisition, transmission, recording and processing systems.

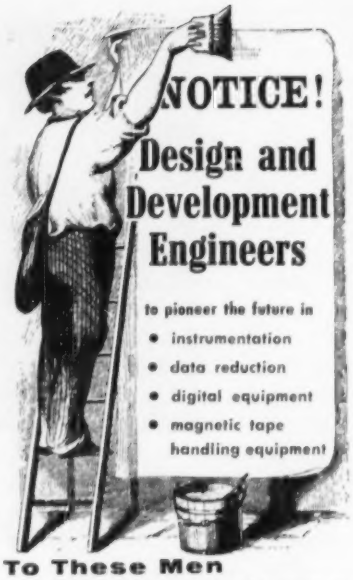
A world leader in electronics provides instrumentation for the Air Force Long Range Testing Laboratory, which extends from Patrick Air Force Base, on the Central East Coast of Florida, to the Mid South Atlantic.

You will enjoy top salaries, liberal company-paid benefits, and ideal Florida living for you and your family. Relocation assistance, too.

TODAY . . . *get complete information on arrangements for personal interview. Send a complete resume of your education and experience to:*

PERSONNEL MANAGER
MISSILE TEST PROJECT—Dept. N-10D
P. O. Box 1226
Melbourne, Florida

MISSILE TEST PROJECT
Melbourne, Florida



To These Men

- a mechanical engineer who wants to design electro-mechanical devices for instrumentation and data reduction. Must have supervisory ability, BSME, at least 8-10 years experience in this type of work.
- an electronic engineer to supervise a test department for custom instrumentation equipment. BSEE, 3-5 years experience required.
- several electronic engineers equipped with BSEE degrees and 0-5 years experience.

Davies Offers

- a place in the suburban Maryland sun . . . close to the culture of Washington, D. C., far from the cares and annoyances of city life, in an area of good schools, good government, well kept property.
- the chance to be yourself—an individual among individuals, an engineer among engineers—to draw personal satisfaction from the fruits of your labors—to be a wheel, rather than a cog.
- a voice in the future of magnetic tape data recording and instrumentation—the confidence and mutual respect of the men who developed the technique.
- the opportunity to continue your education at such nearby schools as George Washington University, University of Maryland, etc.

Plus

- attractive salaries, air conditioning, advancement, a company-paid-for pension plan . . . in short, as much as *any* company can offer. But we offer, in addition, the sheer pleasure and gratification that makes a job a career.

For an interview, write, enclosing resume, to

Mr. Gomer L. Davies
Davies Laboratories, Inc.
Riverdale, Maryland

Davies

EMPLOYMENT OPPORTUNITIES

CHALLENGING OPPORTUNITIES

IN • Avionics • Inertial Systems
• Computers • Missile Guidance
• Jet Engine Fuel Controls

WITH AC THE ELECTRONICS DIVISION OF

General Motors

ALL GRADUATE ENGINEERS are offered permanent job opportunities. We extend a cordial invitation to every deserving Engineer and Designer to write us their wants. We may be able to supply the square hole for the square peg!

YOUR FUTURE depends on your making the right connection with the right firm as quickly as possible.

The men hired will enjoy working with some of the top men in the field and with the finest test, research and development facilities. GM's long-standing policy of decentralization creates individual opportunity and recognition.

Why not send us full facts about your education, work background, etc. We will do all we can to treat your application with the fullest confidence.

AC SPARK PLUG — THE ELECTRONICS DIVISION
GENERAL MOTORS CORPORATION
MILWAUKEE 2, WIS. — FLINT 2, MICH.

ENGINEERS

Put Yourself Ahead in Engineering

with the AMF *Leadership*

MECHANICAL ENGINEERS

Mechanical or electromechanical engineers familiar with the packaging of military electronic equipment, vibration, shock and other environmental problems, kinematic design of mechanisms.

ELECTRONIC ENGINEERS

Experienced in Product Design and Production. Production liaison requires wide knowledge of electronic circuits and packaging. System and Component Testing. Some experience in cost estimating and project administration. Familiarity with all types of military specifications.

SYSTEMS SPECIALIST

Analysis of electronic system performance and establishment of design parameters for electronic systems. Able to prepare or supervise preparation of technical proposals and act in capacity of technical advisor on engineering program. Approximately 10 years experience in general electronic design work.

FIELD ENGINEERS

Experience in radar, ultrasonics, servomechanisms, or computers. Positions involve field assignments in the continental United States after in-plant training.

AMP is well known for its liberal benefits program. Join AMF in Boston where a gigantic electronics boom is on . . . in fact, this is the new electronics center of America. Here you will be surrounded by the nation's leading universities—M.I.T., Harvard, Tufts—outstanding historical sites and gateway to all New England's four-season resorts and sports, easily accessible on new super-highways—and our smart, modestly priced home communities are models for today and tomorrow.

Please forward your resume to Personnel Manager

Electronics Division
AMERICAN MACHINE & FOUNDRY CO.
1085 Commonwealth Avenue • Boston, Mass.

MECHANICAL & ELECTRICAL

ENGINEERS

All Levels

More Than A Career,

LEAR, Inc.

offers you

A Way of Life

—a way to work

Since it was founded 25 years ago, LEAR, Inc. has maintained an uncompromising standard of quality in high-precision electronic and mechanical accessories, devices and instruments for the aviation industry. Among these are: Servo Systems, Magnetic Modulators, Stable Gyro Platforms, Magnetic Sensing and Guiding Devices, Precision Actuators and Electronic Switches. Today these standards have helped create a large and ever-growing demand for LEAR products. This is the LEAR "way to work"—its problems and achievements—which we offer to share with qualified engineers.

—a way to live

You create an entirely new way of life when you make your home in Grand Rapids, Michigan. In addition to the many cultural and educational facilities, you will find a thriving yet uncongested community . . . neighborly people . . . and the unlimited recreation and relaxation that the beautiful surrounding countryside offers.

We Now Have Openings

for men with varying degrees of experience in research, design and development.

To Arrange Interview
send resume to:
Employment Manager

LEAR, Inc.
110 Ionia Ave., N.W.
Grand Rapids 2, Mich

ENGINEERS

for immediate placement

ELECTRICAL ENGINEERS
MECHANICAL ENGINEERS
ELECTRONIC ENGINEERS
COMPUTER ENGINEERS
SOLID-STATE PHYSICISTS

Engineering at NCR:

1. Immediate, permanent positions in Mechanical Engineering, Electrical Engineering and Physics Research Divisions.

2. Engineering project work in Adding Machines, Cash Registers, Accounting Machines, Computers and related Data Processing Equipment in Dayton, Los Angeles, and Ithaca, New York.

3. Opportunities in design, development, production-engineering and packaging of mechanical, electronic, and electromechanical devices.

4. Some experience in development, design, and application of high-speed, light-weight mechanisms of the intermittent-motion type; or, experience in digital devices and components, is desirable, but not essential.

5. Ample training and indoctrination is available to all employees.

As an NCR engineer you, with your family, will enjoy:

1. UNLIMITED OPPORTUNITY in the broad, ever-expanding field of Business Machine Engineering and Research.

2. AN EXCELLENT SALARY, plus exceptional benefits of lifetime value for you and your family.

3. A RECREATIONAL PROGRAM for year-round enjoyment of the entire family, including a new NCR Country Club with 36 holes of golf, and a 166-acre employees' park for outings with swimming, boating, and supervised play for the children.

4. LIVING IN DAYTON . . . considered a clean, attractive, progressive city with outstanding school facilities.

5. YOUR WORK AT NCR with its friendly, family atmosphere, with its employee morale at a very high level, and with people who, like yourself, have decided to build their professional future with NCR.

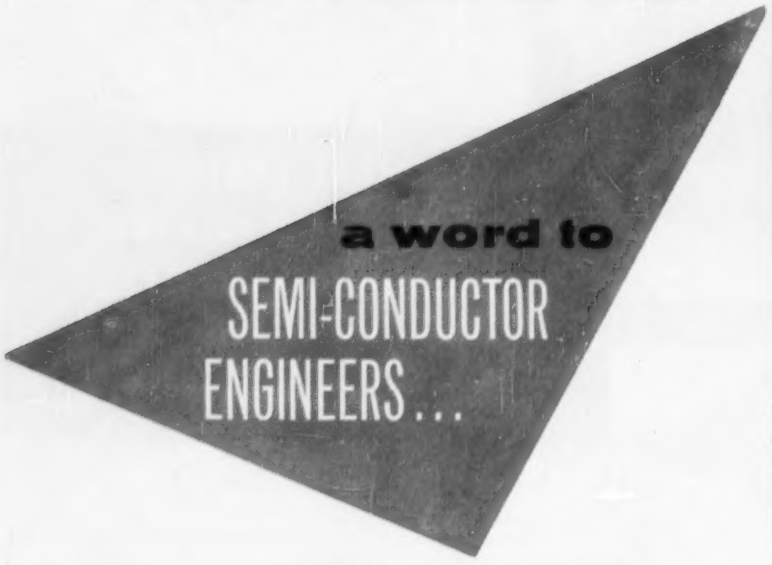
National*

ACT AT ONCE — Send résumé of your education, experience and geographic preference to:

EMPLOYMENT DEPARTMENT, TECHNICAL PROCUREMENT SECTION 4

THE NATIONAL CASH REGISTER COMPANY
Dayton 9, Ohio

*Trade-Mark—Reg. U. S. Pat. Off.



How to Keep at the FOREFRONT of DEVELOPMENTS in your field

The best method, quite simply, is to join the staff of a company where continuous, intensive, massive research activities are constantly improving transistor performance and introducing basic innovations in this burgeoning world of the semi-conductor.

Not only is Sylvania the world's largest manufacturer of crystal diodes, but it is also a notable pioneer in this area, responsible for such developments as the practical miniaturization of transistors. Only last year SYLVANIA developed the metallurgical process which so greatly increases the electrical stability and life of tiny germanium diodes.

Inevitably, engineers and scientists who work at SYLVANIA's Electronics Division march at the forefront of the procession, professionally speaking. And they enjoy the added advantages of association with a company of outstanding stability, diversity and record of growth. (In 54 years Sylvania has grown from a one-plant company to an organization with 43 plants and 16 research and engineering laboratories.)

Salaries are high and company policies contribute in every way to peace of mind and personal progress. Comprehensive benefits include life, accident, hospital-medical-surgical insurance and a unique savings and retirement program—one of the most advanced in industry. Also liberal educational aid.

POSITIONS OPEN AT THIS TIME

for men with semi-conductor experience or a degree in Electrical, Mechanical Engineering, Chemistry, Physics or Metallurgy.

Please forward complete resume to
Miles R. Weaver, *Personnel Manager*
Electronics Division

SYLVANIA
SYLVANIA ELECTRIC PRODUCTS INC.
100 Sylvan Road, Woburn, Mass.

ELECTRICAL ENGINEERS
Physicists

Immediate openings in fast-growing field of

SEMI-CONDUCTORS

Permanent career positions with General Electric in Syracuse, New York . . . for development, instrumentation, design and processing of transistors and rectifiers.

Unusual opportunity for electrical engineers and physicists with B.S., M.S. or Ph.D. degrees.

Chance to work with the industry's leading engineers and scientists . . . under ideal working conditions in modern laboratories, fully equipped with all facilities.

To learn more about your G-E opportunity to live and work in the heart of New York's vacation land, write today to:

Mr. M. D. Chilcote,
Department 156-E
Electronics Park
Syracuse, New York

GENERAL ELECTRIC

QUICK SOLUTION
to
MAN POWER PROBLEMS

through the EMPLOYMENT OPPORTUNITIES SECTION of this publication. The market place for those offering or wanting the services of men on engineering, technical and executive level.

This section offers a quick, effective solution to your man power problems. Because its readership is confined to just the type of men you need, waste circulation is avoided . . . You reach only the men you want.

CLASSIFIED ADVERTISING DIVISION

ELECTRONICS
330 WEST 42ND ST.
NEW YORK 36, N. Y.

EMPLOYMENT OPPORTUNITIES

THE SHOT HEARD 'ROUND THE WORLD

History is repeating itself . . .

Making history is natural to this area . . . And now Raytheon is pioneering in the development and production of complete MISSILE SYSTEMS to aid in the defense of our country.

Raytheon's Missile Systems Division has prime contracts for the development of complete missile systems. Our activities in the missile field range from study programs through design, development, flight tests and production.

EXCELLENT OPPORTUNITIES for

MICROWAVE ENGINEERS
Senior and Junior Engineers with antennae design or component design experience.

CIRCUIT DESIGN ENGINEERS
2 or more years' experience in independent circuit design and analysis.

SPECIFICATIONS ENGINEERS
For writing development, process, and manufacturing specifications for missile and radar systems and components.

ELECTRONIC PACKAGING ENGINEERS
For product design and packaging of missiles and missile systems equipment.

ELECTRONIC SYSTEMS ENGINEERS
Experience in design or systems analysis of missile and radar systems.

Additional opportunities for Tube Applications Engineers, Mechanical Designers, Test Engineers, and Technical Writers.

Write giving a few details on your experience to G. P. O'Neil

RAYTHEON MISSILE SYSTEMS DIVISION

BEDFORD, MASS.

OPPORTUNITY IN SOUTHERN CALIFORNIA

excellent salaries for—

DIGITAL COMPUTER ENGINEERS

who can fill key creative posts in long-range, non-military research and design

FOR ADVANCED BUSINESS COMPUTER SYSTEMS

*

SENIOR ELECTRONICS ENGINEERS

To specialize in research and design for advanced business computer systems. Must have exceptional creative ability, plus knowledge of vacuum tube circuit design, transistor circuitry.

*

SENIOR DIGITAL COMPUTER ENGINEERS

For projects in advanced computer design, development and application. Must have thorough knowledge of digital computer logic and circuitry, input-output devices, programming.

*

TRANSISTOR CIRCUITRY ENGINEERS

For advanced research and design in computer transistor circuitry. Capabilities should include ability to direct others in new project work.

OPPORTUNITY FOR ELECTRONIC OR ELECTRICAL ENGINEERS

Background in one or more of the fields below equips you for excellent career positions with NCR Electronics Division:

LOGICAL DESIGN • FERROELECTRICS • MAGNETIC CORES • COMPUTER SYSTEMS • TRANSISTOR CIRCUITS • INPUT-OUTPUT DEVICES APPLICATIONS OF PHYSICS • COMPUTER SYSTEMS SPECS. DEF. OF SYSTEM REQUIREMENTS

"GROUND FLOOR" OPPORTUNITY WITH UNUSUAL STABILITY

Openings listed here are for the basic organization of the NCR Electronics Division. If you qualify for one of them, you'll be a key member of this fast-developing division of one of America's top companies. You'll enjoy the freedom of a small, select research group — operated *by* engineers *for* engineers — as well as the exceptional financial stability of a large, long-established firm. A full program of employee benefits, too. New, modern, air-conditioned plant with every modern research and development facility in a conveniently situated Los Angeles suburb.

* *For illustrated company brochure, write Director of Personnel.*

National*

*TRADEMARK

NATIONAL CASH REGISTER COMPANY
ELECTRONICS DIVISION *3348 West El Segundo Blvd., Hawthorne, Calif.*

ENGINEERS

The APPLIED PHYSICS LABORATORY of THE JOHNS HOPKINS UNIVERSITY offers an exceptional opportunity for professional advancement in a well-established Laboratory with a reputation for the encouragement of individual responsibility and self-direction.

Our program of

GUIDED MISSILE RESEARCH and DEVELOPMENT

provides such an opportunity for men qualified in

- Design and Analysis of Pulse Circuits
- Research and Development in Radar and Microwaves
- Electronic Packaging
- Development of Telemetering, Data Processing, and Special Switching Equipment
- Magnetic Amplifier Design & Analysis
- Development and Application of Printed Circuits
- Servomechanisms and Control-System Analysis

Please send your resume to
Professional Staff Appointments

APPLIED PHYSICS LABORATORY
THE JOHNS HOPKINS UNIVERSITY
8609 Georgia Avenue
Silver Spring, Maryland

Electronic Development Engineers

A *real opportunity for personal recognition.* Non-government work on complete product design projects with established manufacturer of industrial TV cameras, amplifiers, receivers, frequency converters, etc.

Must be prepared to work independently. See your own ideas through — from blueprint to finish — ready for market. Modern lab facilities at your complete disposal.

B-T LABS

Write or Telephone

BLONDER-TONGUE LABS., INC.
Westfield, New Jersey
WEstfield 2-7032

CHALLENGING CAREERS AT RAYTHEON

Bendix Aviation Corporation
YORK DIVISION

YORK, PENNSYLVANIA
TELEPHONE YORK 5521

Dear Engineer,

If you are a fortune-hunter, turn the page; this is not for you. But if you are one of the great majority of professional men who is primarily interested in a satisfying job and attractive working and living conditions with reasonable security and good promise for the future, read on!

Sure, this is a sales pitch - but different, since it aims to be honest! We need Engineers, just like every other leading company. You've seen the screaming ads promising Utopia, or Nirvana, to anybody with any semblance of engineering qualifications. We're different! At York, we cling to the belief that you will be more impressed with a frank statement of the pros and cons.

First, we are in the electronics business. Most of our work is military. Since we are working with five or six government agencies, our activities are diverse. We are a small, but full-fledged division of the Bendix Aviation Corporation, which conveys the security and stability of a large company. On the other hand, Bendix operates its divisions on a practically autonomous basis, so that we also have the flexibility and healthy atmosphere of a small, independent company. Nobody gets buried!

The plant is 100,000 sq. ft. big - about 3 years new and excellently equipped with machinery and test equipment. The plant is located about five miles east of York, Pa., on the Lincoln Highway, in what the real estate dealers describe as a "beautiful suburban area". (And it is.) You can live (as I do) within three minutes drive of the plant. For $10,000 you can have a 2-bedroom house (cheaper if you buy a run-down farm house).

The town (of about 75,000) has at least one of everything you could find in a bigger city, including a symphony orchestra of some note. (Sorry, the pun was unintentional.)

Here in our plant, we believe that engineers are people, individuals yet, and not hired hands. We exercise some care in hiring, because we want them to stick; and, in fact, our turn-over rate is negligible. The work and status of each individual is reviewed every six months. This doesn't mean that he gets a raise every time, but 10% a year isn't far from the average. As an engineer, it's possible to make over $10,000 a year, but you have to be good.

We operate basically by a project system, with a great deal of responsibility vested in each Project Engineer. The supporting departments - Drafting, Mechanical Engineering, Model Shop (you should see our Model Shop), technical publications and the like - furnish service to the project groups. We do about $1,000,000 a year engineering business alone, and seem to have no difficulty in acquiring more. We're growing fast!

We don't offer you the moon, but we do offer you a fair shake!

Sincerely yours,

K. F. Umpleby

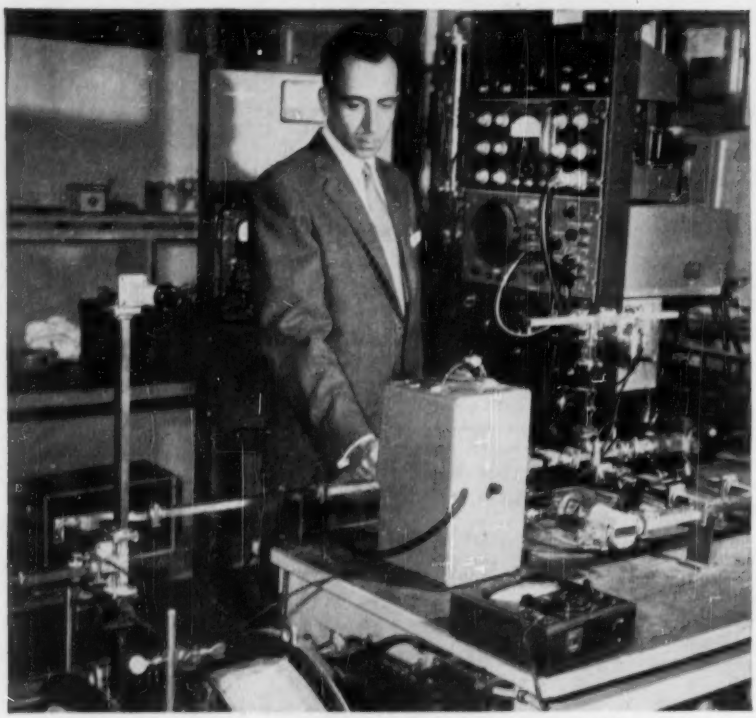
P.S. If what I've said interests you, get in touch with me!

K.F.U.

K. F. Umpleby
Chief Engineer

EMPLOYMENT OPPORTUNITIES

CHALLENGING CAREERS AT RAYTHEON



Studying ferromagnetic resonance. A cavity perturbation method is used, in which a ferrite specimen placed in a high Q microwave cavity changes cavity properties in accordance with electrical and magnetic properties of the material.

Looking for a good place to grow?

When you join Raytheon you work in an atmosphere of progress. Advanced work on ferrites for microwave applications is proceeding in Raytheon's modern ceramic research facilities. Various types of gyrators, isolators and other ferrite microwave devices have resulted from development work in the equipment systems and component development laboratories.

University graduate study is encouraged through a tuition refund plan. Openings now for engineers, scientists in many areas including:

microwave tubes • special purpose tubes • guided missiles
transistors • diodes • receiving tubes • TV receivers • radar
metallurgy • ceramics • communications • cathode ray tubes
sonar • servomechanisms • solid state physics • field engineering

Join a team where performance pays off. Please address inquiries to L. B. Landall, Professional Personnel Section.

RAYTHEON

RAYTHEON MANUFACTURING COMPANY
190 Willow St., Waltham 54, Mass.
Plants also located in California and Illinois

SENIOR

ELECTRONIC ENGINEERS

Enjoy Professional Respect—and fine Connecticut life

If you have an EE degree, and servo-mechanism experience, and have (or can be given) security clearance, you can qualify for an excellent position in our long-successful company, situated in one of Connecticut's most pleasant environments, with access to mountains, lakes and sea.

Here, your experience and intelligence will be well respected and rewarded, and you, with your family, will enjoy the benefits of living in beautiful Connecticut.

We will hold your resume in strict confidence. *Write today to*

P-9482, Electronics
330 W 42 St., New York 36, N. Y.

Avail. Jan. 15, poss. sooner.

55 Positions Wanted

ELECTRONIC ENGINEER — Exp., except'l record, wants empl. with growing Calif. electronics co. recognizing tech. proficiency, offering real opp. for advancement. Prefer S. F. vicinity, nr. good housing, schools.

Assistant. Competent, agreeable. Gd.

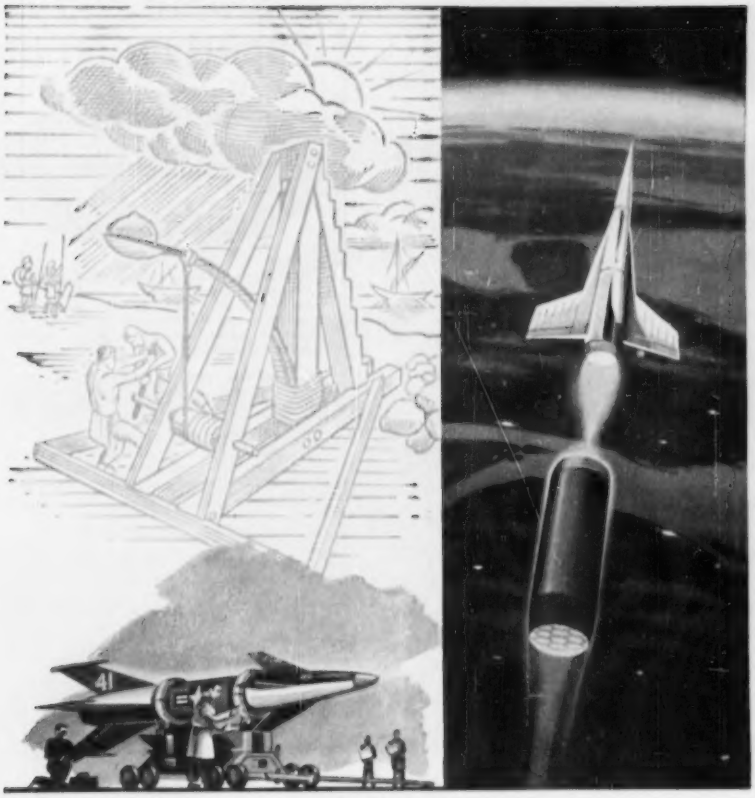
why is this engineer looking for a job?

. . . Because he wants more opportunity for advancement than most companies can offer. If an electronic engineering job with an unusual career potential interests you, write for our new brochure on engineering opportunities at Varian.

Address:
Personnel Director Varian Associates
Stanford Industrial Park, 611 Hansen Way
Palo Alto, California

VARIAN associates

EMPLOYMENT OPPORTUNITIES



ONE OF A SERIES — depicting missiles — "Yesterday, Today and Tomorrow"

Συστήματα Ὅπλων

. . . in Greek means *weapons systems;* and, with the catapult, the Greeks developed one of the earliest weapons systems. Perfected slowly, it reached the height of its effectiveness during the Middle Ages. Today's weapons systems concepts are tremendously more complex than the ancient catapult. The swift advances of science enables only the highly integrated engineering teams to keep pace with the changes. Combined with a perceptive management policy, such a team in a relatively short time can achieve a goal that once took centuries.

At Bell there is both progressive management and creative engineering teams. With that years-ahead look, Bell is concerned not only with today's problems but with tomorrow's successes. Backed by years of successful missile development and management, Bell is now engaged in new projects in advanced missile design. To the creative engineer desiring top assignments, this is an opportunity to work on a *completely new weapons system.* For qualified engineers with a B.S. or advanced degree, Bell is offering positions where a high level of professional achievement may be attained.

DEVELOPMENT ENGINEERS

for Weapons System Engineering

- Development of detailed operational concepts and requirements for a missile weapon system.

- Loop analysis and evaluation (aero, servo, seeker, warhead, fuse, rocket) to arrive at optimum system design. Experience on servo systems or guidance systems highly desired.

DESIGN ENGINEERS

- Establish reliability criteria for weapon system elements; formulate, monitor and perform continuing analysis of a test program to yield all necessary reliability data.

- Hydraulic installations — design and layout installations. Experience with aircraft or missile hydraulic devices desired.

- Control and coordinate designs and changes to elements of missile support equipment system. Experience affording broad knowledge of electronic, hydraulic and mechanical elements in a complex system is highly desired.

PROJECT ENGINEERS

- To assume responsibility for technical coordination on weapon system requirements between project group, manufacturing/test activities and contractor.

FLIGHT TEST ENGINEER

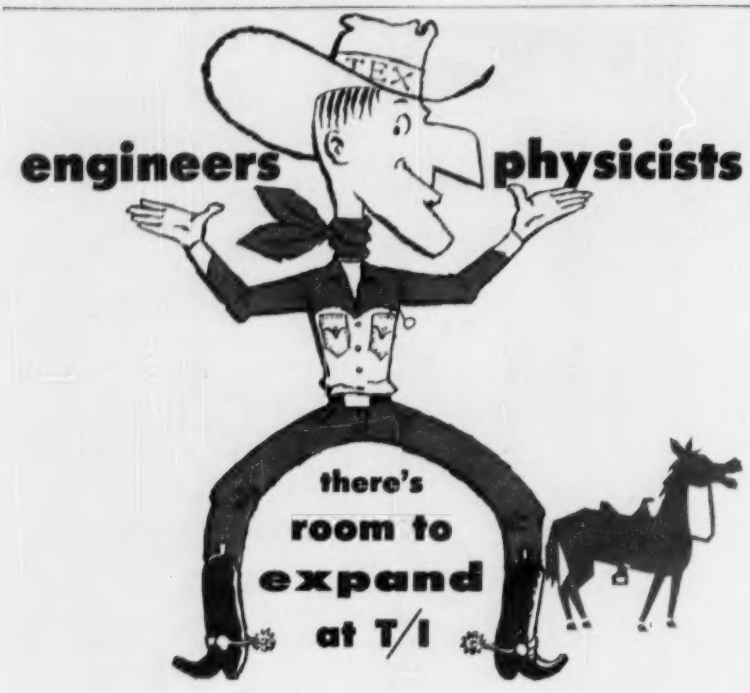
- Establishment and coordination of instrumentation requirements for weapon system test program. Determination and coordination of range safety requirements and test objectives.

We invite inquiries concerning your association with Bell Aircraft. Contact: Manager, Engineering Personnel

BELL Aircraft CORPORATION

P. O. Box 1 Buffalo 5, N. Y.

EMPLOYMENT OPPORTUNITIES



Texas Instruments expanding research and development programs have opened outstanding opportunities for physicists (solid state) and electronics engineers. TI offers you real chances for advancement in a rapidly-growing industry. Positions are now available in the following fields of engineering:

Transistor device development
Transistor circuit applications
Automation and test equipment design
Microwave component development
Infrared radiation development
Transformer design
Resistor engineering
Electrical meter design
Production planning and control

At Texas Instruments you will have the long-range stability of a 25-year-old firm with many notable "firsts" in the fields of semiconductors, geophysics, radar, infrared radiation, and others. You will enjoy the many living, cultural, and recreational rewards of the sunny Southwest. We would be glad to discuss these career opportunities with you . . . our profit-sharing plan and other personnel advantages at Texas Instruments.

Write to Personnel Director

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

opportunities in

OPERATIONS RESEARCH

Operations Research Office of The Johns Hopkins University offers exceptional opportunities for scientists who prefer the challenge of operational problems of unusual scope and diversity to routine design and development work.

Our current research program has openings for men qualified in electronics and physics who are particularly interested in:

- Mathematical Analysis
- Determining applications of known photographic, acoustic, infrared and radar techniques to military problems
- Military communications systems planning, analysis and evaluation
- Electronic Countermeasures Analysis

Please send your resume to Research Personnel Officer

OPERATIONS RESEARCH OFFICE

THE JOHNS HOPKINS UNIVERSITY
7100 Connecticut Avenue
Chevy Chase, Md.

ELECTRONIC ELECTRICAL ENGINEERS

Permanent positions are available at all levels of experience in the Communications and Radio Frequency section of a large Midwestern research and development organization. We need qualified personnel to work in:

Electronic Countermeasures
Microwaves
Radar
Antennas and Propagation
Radio Interference
Communications Systems

Here is an excellent opportunity to join the staff of a progressive organization, work on challenging and diversified research programs, receive liberal educational benefits, and enjoy optimum professional associations. New air-conditioned facilities are under construction, and will be available shortly.

Write to:
J. A. Metzger

ARMOUR RESEARCH FOUNDATION
of Illinois Institute of Technology
10 West 35th Street, Chicago 16, Illinois

REPRESENTATION WANTED

Rapidly growing nationally known transformer manufacturer desires effective representation Metropolitan N. Y., Pacific Northwest, Ohio, Minn., Wis., Iowa

RW-1632—Electronics
520 N. Michigan Ave., Chicago 11, Ill.

Every path to success

. . . each highway to achievement . . . must have a beginning and what better place to start than right here . . . in the new ultra-modern multi-million dollar Research Center which is only one of three erected in the immediate area within the past 3 years.

Located on Philadelphia's Main Line, within sight of historic Valley Forge, Burroughs multi-unit Research Laboratories are less than an hour by train or car over express highways to Philadelphia where cultural and educational facilities of known merit are available to engineers interested in advance study at The University of Pennsylvania, Drexel Institute or Temple University during the evening hours.

Naturally, a retirement program and other benefits for you and your family are part of Burroughs Progressive Employment Policies. So, too, is association with outstanding men in the business machine field.

Looking to future expansion, Burroughs invites inquiries from those qualified as:

ELECTRICAL ENGINEERS • PHYSICISTS • ELECTROMECHANICAL ENGINEERS

MECHANICAL ENGINEERS • TECHNICIANS • MECHANICAL DESIGN ENGINEERS

. . . in the following fields — Control Computers, Pulse Circuitry, Digital Computers, Optical Devices, High Speed Mechanisms, Guided Missiles, Solid State Circuitry, Electronic Packaging, Electrographic Recording Devices.

Burroughs
CORPORATION
RESEARCH CENTER
PAOLI, PA., NEAR HISTORIC VALLEY FORGE

Send Complete Resumé to
M. E. JENKINS
PLACEMENT MANAGER
For Interview at Your Convenience

FIELD ENGINEERING
WITH A FUTURE—at Raytheon

PLAN YOUR CAREER HERE — Raytheon needs men like you who are qualified for field engineering and have the ability to build a future in electronics. Experience in the field has enabled many of our engineers to become executives at Raytheon. Unlimited opportunity is open to you now in the following programs:

MISSILES	**Air-to-Air – Ground-to-Air**
RADAR	**Search – Fire Control** **Bombing – Countermeasures**
Other Equipment....	**Ship and Airborne Sonar – Multiplexers – Microwave Relay Links – Communications**

Raytheon has designed and built complicated electronic equipment for the past 30 years. One of its present equipment projects is the world's most publicized radar—the DEW LINE radar.

If you have a college degree, you'll rate preference. However, if you have an extensive electronic background, send in your application. Special training will be provided by our Training Facility to prepare you for your assignments.

Attractive salaries, benefits, and allowances. Domestic and overseas assignments.

RAYTHEON

RAYTHEON MANUFACTURING COMPANY
100 River St., Waltham 54, Mass.

RECENT ENGINEERING GRADS

ARE YOU INTERESTED IN GETTING AN ADVANCED DEGREE?

If you want to combine work and study, and at the same time gain experience in research techniques, full time employment opportunities are available in aerodynamic research projects utilizing wind tunnel facilities. Any type of engineering training from an accredited college acceptable. Submit details of background to Mr. F. K. Womack:

University of Minnesota
Aeronautical Engineering Lab
Rosemount Research Center
Rosemount, Minnesota

DRAKE PERSONNEL

National Placement Center for
EXECUTIVE AND TECHNICAL PERSONNEL

General and Plant Managers
Plant Superintendents—Foremen
Accounting—Staff Personnel
Engineers: Design—Production
Sales Managers—Engineers

Please outline briefly your experience or personnel needs to:

John Cope
220 S. State St., Chicago 4, Ill.
HArrison 7-8600

ENGINEERS — SCIENTISTS

$6000 – $20,000

WORLD-WIDE PLACEMENT

NO FEE

Industrial counseling service with an intimate knowledge of the engineering market. Relocation expenses and placement fees paid by employers.

Resumes acknowledged immediately, specify position preferred and geographic location desired.

1346 Connecticut Ave. NW Washington 6, D. C.

ANN PALMER HAYNES
Industrial Personnel Consultant

ELECTRONIC PROJECT ENGINEERS

$8400 to $12,000 a year. Experienced in all types of Electro-Mechanical design, research and development on Electro-Mechanical products. Capable of successfully directing groups of engineers. Send complete resume to:

J. J. COOPER
64 E. Jackson Blvd. Suite 940
Chicago, Ill. WAbash 2-1918
Prompt and confidential service

ENGINEER — STAFF

Major manufacturer of air borne fire control and missile systems, seeking a staff engineer to coordinate detection program. Should possess knowledge of infra-red detection systems. Salary $12,000 per year. Company pays all expenses.

MONARCH PERSONNEL
28 E. Jackson Blvd. Chicago 4, Ill.

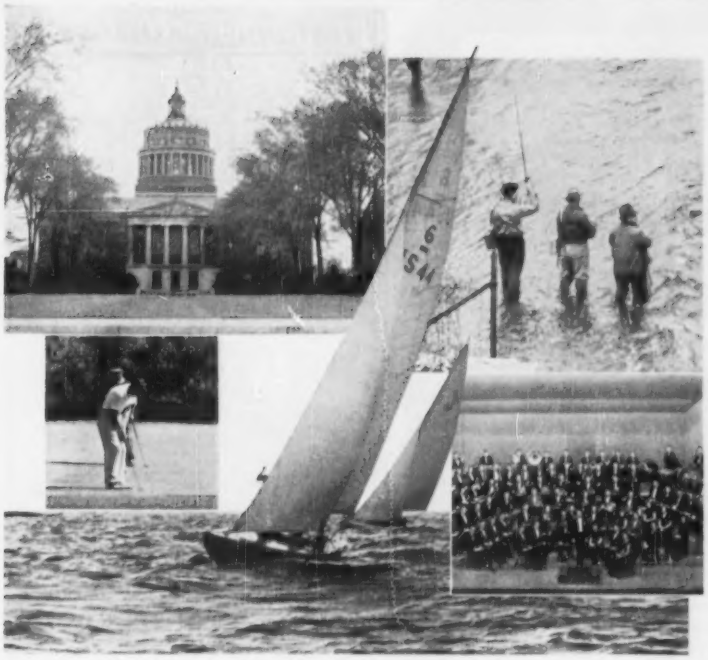
CHIEF ELECTRONIC ENGINEER

$10,000 to $15,000 a year. Capable of directing multi-project groups. Will supervise engineers from initial design to finished product. Opening created through expansion program. Send resume to:

J. J. COOPER
64 E. Jackson Blvd. Suite 940
Chicago, Ill. WAbash 2-1918
Prompt and confidential service

An employment advertisement in this EMPLOYMENT OPPORTUNITIES section will help you find the engineers you need. It's an inexpensive, time saving method of selecting competent personnel for every engineering job in the electronic field.

EMPLOYMENT OPPORTUNITIES



You'll find your future in one of these specialized areas

RESEARCH

Communication and Data Systems • Information Theory • Semi-Conductor • Digital Techniques • Servo Mechanisms • Electronic Switching • Acoustic Transducers • Magnetic Amplifiers • Nucleonics • Microwave and Wireline Carrier

ELECTRONICS

Radio Communications • Mechanical Design Engineering • Infrared • Automatic Test Systems • Countermeasures • Navigational Systems • Radar • Computer Techniques • Military Transistor Applications • Missile Guidance Systems • Microwave Development • Electronic Communications

AUTOMATION

Systems Engineering • Automatic Assembly • Transistors • Amplifiers & Filters • Automatic Test Equipment • Numerical Control • Computers • Counters • Instrument and Power Servos • Production Engineers

WIRE COMMUNICATION

Dial Central Office Equipment • Telephone Instruments • Wireline Carrier • Frequency Multiplex • Toll Ticketing • Transistor Circuitry • Microwave Links • Electro-mechanical Design • Electronic Switching Systems

AUDIO-ACOUSTICAL

Transformers • Tape Recorders • Audio Amplifiers • Loudspeakers • Electronic Carillons • Intercommunication Systems • Auto Radio • Home Radio • High Fidelity Music Reproduction • Sonar

A land with a climate where your *ideas* can *grow*

You begin to hunt for such a climate when you see your ideas stagnating in the airless confines of a company too small—or lost in the bog of one that's too big.

You promise yourself it's climate you'll look at, *this* time when you pick a job. *Management* climate—because that's where ideas find sunshine—not the big freeze.

So you look for a company where Management recognizes a hot idea when it comes up from the lab. You look for a company where Sales knows how to take hold of a good idea and move. You search for a department without pigeon holes; you want to work, not roost.

That's why Stromberg-Carlson's story should appeal to you. Since World War II our volume has increased 16 times, thanks to good ideas accepted and promptly applied. Recently we joined the headline-making General Dynamics Corporation, making the ionosphere the limit on your future here.

As two or three generations of Stromberg-Carlson engineers can tell you, the climate in this scientific-industrial city of Rochester seems to stimulate live minds. You meet next-door neighbors who know what you're talking about. You enjoy winter sports, summer boating, good music, fresh theater—and a salary-bonus plan that lets the good way of living be yours. It should be, when you choose a *lifetime* job.

The list at right shows where there's room for you and your ideas to grow. Dig in now—with a detailed letter to Mr. Howard L. Foote, at the address below. We think you'll like what he has to say to you.

S-C

STROMBERG-CARLSON COMPANY

A DIVISION OF GENERAL DYNAMICS CORPORATION

ROCHESTER 3, N. Y. • Plants at Rochester, N. Y., Los Angeles, Calif., and San Diego, Calif.

FLIGHT TEST INSTRUMENTATION ENGINEERS

Do you qualify for one of these unusual and difficult positions offered by Republic Aviation? The opportunity for growth and professional advancement is exceptional, the salaries are tops, the benefits many . . . including Republic's now famous Retirement Income Plan offering: (1) a basic program paid in its entirety by the company; and (2) a cooperative plan for even *greater* retirement income with Republic more than matching your contribution.

Positions open for:

PROJECT FLIGHT TEST INSTRUMENTATION ENGINEER

5-7 years experience. Must be capable of: (1) co-ordinating the activities of an engineering group; (2) translating the flight test engineer's requirements into instrumentation specifications capable of fulfilling the specific test requirements; (3) performing the basic systems engineering on a given project.

FLIGHT TEST INSTRUMENTATION ELECTRONIC ENGINEER

Airborne Magnetic Tape Specialist

Opening for engineer presently involved in the development and/or use of Magnetic Tape Recorders for Airborne Data Acquisition System. Must have a thorough knowledge of the present state of of the art and a good understanding of FM/FM and PWM systems.

Telemeter Specialist

3 years experience minimum. Must have a thorough understanding of FM/FM and PWM telemeter systems and be capable of directing the operation of the telemeter ground station and checkout of the airborne system. The opportunity exists for the advancement into the field of PWM and FM/FM to Digital Converters.

FLIGHT TEST INSTRUMENTATION DEVELOPMENT ENGINEER

5-7 years experience. Must be capable of supervising the activities of a development group. A basic working knowledge of the fundamental laws of physics required together with heavy experience in advanced flight test instrumentation. Responsible for: (1) systems engineering on advanced instrumentation projects; (2) design and development of specialized instrumentation components not commercially available; (3) design and development of circuitry and techniques required to make various transducers compatible with various methods of recording.

FLIGHT TEST INSTRUMENTATION ENGINEERS

1-3 years experience. Several openings for electrical engineers and physicists with an instrumentation background who wish to adapt their present instrumentation experience to the challenging field of flight test instrumentation. Mechanical Design engineers are required for designing the installation of instrumentation in flight test aircraft.

Please forward complete resume, including details of your technical backgound, to:

Assistant Chief Engineer
Administration
Mr. R. L. Bortner

REPUBLIC AVIATION
FARMINGDALE, LONG ISLAND, NEW YORK

PERSONNEL MANAGERS

Looking for Engineers . . . Technicians?

Write for free copy of

"RESERVOIR of ENGINEERS and TECHNICAL MEN"

The engineers and technicians you want to reach are gathered in convenient, compact groups—as this 12-page booklet points out.

It keys the job titles these men hold to the McGraw-Hill publications they read for on-the-job information. It explains how you can make contact . . . channel, concentrate your employment advertising to just the men with the job qualifications you want . . . without wasting advertising money for higher-priced space in publications with general circulation, in which you pay for perhaps 999 unqualified readers for every 1 who may meet your job requirements.

Write for your free copy to
Classified Advertising Division
McGraw-Hill Publishing Co., Inc.
330 W. 42nd St., N. Y. 36, N. Y.

EMPLOYMENT OPPORTUNITIES

WILL YOU BE LITTLE WITH A BIG COMPANY

A C.A.C. Engineering-Management Conference

OR BIG WITH A FAST GROWING COMPANY?

COMMUNICATION ACCESSORIES COMPANY . . . in suburban Kansas City, offers you advantages not available in other companies . . . other localities.

THIS IS "OPPORTUNITY" KNOCKING . . . NOW IS THE TIME TO ACT! C.A.C. has urgent requirements for engineers who have specialized, or would like to specialize in the following:

Magnetic Amplifiers
Small Servo Motors
Magnetic Cores and Materials
Relays
Precision Potentiometers
Mechanical Filters
Precision Saturable Reactors
Laminated Transformers
L-C Type Filter Networks
Coil-winding Machines
Plastic Encapsulation Processes and Methods

Salary? Initial salary based on evaluation of education, experience and past accomplishment record. Your income will be re-evaluated bi-annually by a salary committee with strong engineering representation. You are thereby guaranteed of income commensurate with your contributions to C.A.C. SEND US YOUR RESUME TODAY, or depending upon the urgency of your personal situation, phone us collect (Kansas City, SOuth 1-5528).

YOU HAVE HEARD OF OUR COMPANY . . . C.A.C. is the world's largest exclusive producer of toroidal windings. More than 500 persons are employed in 3 nearby locations. Plans call for a new, very modern structure to house the entire operation. Products we manufacture are vital components in a long list of end equipment . . . our customer list is growing every day. Because we are a subsidiary of a World Leader in electronic communication equipment, you will have every advantage of new product development and research.

GROWTH POTENTIAL This is the point which you as an engineer looking for a rapidly advancing career in engineering and engineering management should consider profoundly.

The crowding of the available frequency spectrums will continually dictate the use of more precise frequency selective networks and will include recently developed mechanical filters. Our new developments in magnetic amplifiers, together with the expanding missile program have created the requirements for a vastly increased engineering activity in this field. The present C.A.C. is only a nucleus for the organization which will be required to meet our customers' military and commercial needs.

DIVERSIFIED ENGINEERING ASSIGNMENTS As a C.A.C. engineer you will never become "bored" with your work. Due to the widely varying needs of our customers, practically every assignment is totally new and different. Your experience will broaden and later on, if you feel that specialization is your forte it will be your opportunity. There are challenging developments ahead and you can be in on "the ground floor" in helping to perfect them.

OUR LOCATION OFFERS THE FINEST FOR FAMILY LIVING You really *live* in Kansas City . . . it's known as a city of lovely homes! Here is the world-famous Country Club Plaza, the original shopping center. Our plant location, 20-minutes from downtown Kansas City, offers convenience unheard of in other metropolitan areas. Live close to the plant, go home for lunch if you like. See your children going to wonderful schools, growing up in a wholesome atmosphere. And, living costs in Kansas City are way below many other areas.

They say "everything's up to date in Kansas City" and it's true. It's a hub of air transportation to all points (a fact you will appreciate when you assist sales personnel on engineering project conferences at customer facilities). Entertainment, sports activities and family recreation are big reasons for coming to Kansas City, but most of all, you and your family will appreciate its comfortable living.

OUR AIM . . . THE WORLD'S FOREMOST MAGNETIC AMPLIFIER LABORATORY. In this field where relatively few individuals can speak authoritatively, C.A.C. has become a leader. The vast future of magnetic amplifiers set our plans to build this unique laboratory . . . it is decided and you can enjoy a wonderful future as a part of it.

To say that our ambitions are limited only to magetic amplifiers would be grossly incorrect. Research and development of a most intensive nature will continue over a wide range of products supplementing toroidal designs.

Write or Phone **WAYNE S. BONEBRIGHT,** *Vice President*

COMMUNICATION ACCESSORIES COMPANY

World's Largest Exclusive Producer of Toroidal Windings

HICKMAN MILLS, MISSOURI (A suburb, 20 minutes from downtown Kansas City, Mo.)

Telephone, Kansas City, SOuth 1-5528

C-A-C®

A Subsidiary of Collins Radio Company

SYSTEMS ENGINEERS

LIBRASCOPE offers outstanding opportunities to "career" engineers in military and industrial projects, involving the design of fire control systems, analog-digital computers, transistor and servomechanisms components – packages and many other categories, some of which are listed below. Fields of concentration include mechanics, optics, electronics, magnetics.

DO YOU QUALIFY FOR THESE IMMEDIATE OPENINGS?

AIRBORNE EQUIPMENT ENGINEER
Experienced digital computer engineer. BA or BS in Physics or EE. Experience in magnetic or transistor techniques in pulse circuits desirable.

ELECTRONICS ENGINEER
Project Mgr. to design, develop and check out circuitry in servomechanisms and instrumentation. EE or equiv. Transistor and/or mag. amps. experience desirable.

ENGINEER TO WRITE PROPOSALS
BS in math, physics or Engr. To prepare proposals on military equip. Fire control and guidance systems, analog or digital computers. Extensive experience brings top pay.

SHIPBOARD EQUIPMENT ENGINEER
Assist in proposal preparation for shipboard computing systems & components. EE or Physicist. Experienced in sonar, anti-sub fire control, analog or digital computers. Navy background preferred.

SENIOR ENGINEER
With EE to do analyses of airborne systems. Must have 2 yrs. systems analysis experience in digital computers, ability to write military proposals, and to work out math for computer processing.

MECHANICAL ENGINEER
Experience in electro-mechanical design to take charge of mech. designs in electronics packages. ME degree or equiv. Experience with servos or optical applications desirable.

Join a well-established firm with the "young man's" viewpoint... where each individual works closely with management... stays with his project from start to finish. Excellent pay, subsidiary benefits. Relocation assistance. Contact Don Webster, Chief Engineer.

LIBRASCOPE

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

LIBRASCOPE, INC. · 808 WESTERN AVE. · GLENDALE, CALIFORNIA

FOR RATES OR INFORMATION

About Classified Advertising,

Contact The McGraw-Hill Office Nearest you.

ATLANTA, 3
1321 Rhodes-Haverty Bldg.
WAlnut 5778
W. D. LANIER

BOSTON, 16
350 Park Square
HUbard 2-7160

CHICAGO, 11
530 No. Michigan Ave.
MOhawk 4-5800
W. HIGGENS

CINCINNATI, 37
1915 Rockingham Ave.
kEdwood 1-4537
W. GARDNER

CLEVELAND, 15
1510 Hanna Bldg.
SUperior 1-7000
C. J. LOUGHLIN

DALLAS, 2
Adolphus Tower Bldg., Main & Akard Sts.
PRospect 5064
C. JONES

DETROIT, 26
856 Penobscot Bldg.
WOodward 2-1793
L. SEEGAR

LOS ANGELES, 17
1125 W. 6th St.
MAdison 6-9351
C. W. DYSINGER

NEW YORK, 36
330 West 42 St.
LOngacre 4-3000
W. SULLIVAN
D. COSTER
R. LAWLESS

PHILADELPHIA, 3
17th & Sansom St.
Rittenhouse 6-0670
E. MINGLE
H. BOZARTH

ST. LOUIS, 8
3615 Olive St.
JEfferson 5-4867
W. HIGGENS

SAN FRANCISCO, 4
68 Post St.
DOuglas 2-4600
R. C. ALCORN

EMPLOYMENT OPPORTUNITIES

ELECTRONIC INSTRUMENTATION ENGINEERS

Beechcraft has immediate openings for Electronic Instrumentation Engineers. Three to five years experience in experimental research testing of high speed aircraft or missiles required. Knowledge of instrumentation and telemetry coupled with ability to instrument, record and analyze is essential. Graduates with E.E. degree preferred. Excellent opportunity with a progressive company. *Please address inquiry with resume of past experience to* Roy F. Kunz, Dept. 69E, Beech Aircraft Corporation, Wichita, Kansas.

BEECHCRAFT

COMMUNICATIONS ENGINEERS and TECHNICIANS

EXCELLENT SALARIES
MINIMUM PREREQUISITES

ENGINEER — EE Graduates with 3 years experience

TECHNICIAN — 2 years technical school in communications and 3 years experience.

Require installation adjustment and maintenance experience with communication receivers and associated terminal equipment. Also, men with similar experience with high-powered transmitters, antennas, transmission lines.

Must be willing to travel in United States and Overseas.

Page Communication Engineers, Inc.
710 Fourteenth St., N.W., Washington 5, D.C.

QUALITY CONTROL ENGINEER

Quality control engineer for components manufacturer located in Westchester County. Experience preferred in coils, transformers or audio filters. Apply only if experienced. Position is permanent with a nationally known manufacturer, and salary will be commensurate with experience.

P-1011, Electronics
330 W. 42 St., New York 36, N. Y.

ELECTRONIC ENGINEERS

To those interested in extending the "State of the Art" at VHF and UHF—I. F. I. offers challenging opportunities on long range programs. Wide band experience particularly useful, but not necessary. Expanding electronics firm. All normal fringe benefits.

Send resume or phone.

INSTRUMENTS FOR INDUSTRY, INC.

150 GLEN COVE ROAD — MINEOLA, N. Y.
MR. T. C. VILLA. — PIONEER 2-5300

DYNAMICS

AERODYNAMICS

THERMODYNAMICS

OPERATIONS RESEARCH

HYDRAULICS

MECHANICAL DESIGN

LABORATORY TEST ENGINEERING

UNEQUALLED OPPORTUNITIES IN ENGINEERING

Now is the time . . . Convair is the place! Yes! If you are planning for a career in engineering look to Convair Pomona, the leader in Electronics. America's fastest growing young industry. Now engaged in Design, Development, Engineering and production of Electronic equipment and complex weapons systems. Convair-Pomona is the country's only exclusive guided missile plant, with the most modern, best equipped engineering facilities. Be first with Convair, live in the beautiful Pomona Valley only minutes from Los Angeles, the mountain, seashore and desert playgrounds. Country living near the city at its best!

Generous travel allowance to Engineers who are accepted. Write now enclosing a complete resume to:

Employment Dept. 3-G

CONVAIR
A DIVISION OF
GENERAL DYNAMICS
CORPORATION
POMONA
CALIFORNIA

COOK RESEARCH LABORATORIES

THE FIELD OF RESEARCH OFFERS Satisfying CAREERS

Immediate Openings In—

RADAR — COMMUNICATIONS — MICROWAVE TECHNIQUES — INFORMATION THEORY — CIRCUIT DESIGN — TELEMETERING — PULSE TECHNIQUES — SERVO — FIRE CONTROL — WEAPONS SYSTEMS — MATHEMATICAL ANALYSIS FOR NUMERICAL COMPUTATION — THERMODYNAMICS — AERODYNAMICS — AIRCRAFT INSTRUMENTATION — NUCLEAR PHYSICS — MECHANICAL DESIGN — TEST ENGINEERS, COMPONENT & EVALUATION.

Cook Research Laboratories offers outstanding opportunities in the field of Research and Development for Engineers and Physicists at both the Senior and Junior levels.

Cook Research maintains one of the nation's foremost research and development laboratories and has on its staff men who are nationally known in their respective fields.

At Cook Research, employees are encouraged in the publishing of technical papers. Undergraduate and graduate work is fully subsidized by the company.

The Research division offers highly diversified work in both research and development, excellent salaries and working conditions.

Company products are to be found on all commercial and military aircraft.

The Laboratory activities ARE WORLD WIDE IN SCOPE.

Cook Research Laboratories are located in the northwest suburbs of Chicago. This location is conveniently located to many fine universities, civic and shopping centers and many excellent resort areas.

Contact
D. M. HALLIDAY

• **8100 N. Monticello Ave.**
Skokie, Illinois KEystone 9-2060

• **A DIVISION OF COOK ELECTRIC COMPANY**
2700 N. Southport Ave., Chicago, Illinois

ELECTRICAL AND MECHANICAL ENGINEERING AND MANUFACTURING SINCE 1897

TO BE SPECIFIC...

ABOUT OPPORTUNITIES
IN ELECTRONICS WITH

GENERAL ELECTRIC

ENGINEERS · PHYSICISTS

GE has instituted a new service to aid engineers in making a career choice. Just fill out and mail the coupon below. GE will send you information on openings in your specific field of interest, and the location of these openings.

Every engineer seriously interested in the electronics field should consider what a GE career can mean: the broad scope, the varied opportunities, the exceptional chances for professional achievement. There are personal advantages too: stability, benefits, educational and advancement opportunities.

Bachelor's or advanced degrees in Electrical or Mechanical Engineering, Physics, and experience in electronics industry necessary.

If your professional goals are high, send the coupon below, to learn how and where you can begin your GE career.
(Or send complete resume, if you wish.)

TO: GENERAL ELECTRIC
Electronics Park, Syracuse, New York
ATTN.: Dept. 4-6-E, Technical Personnel

FROM: Name_____
Address_____
_____
Degree_____

I am interested in

- ☐ Advanced development
- ☐ Design
- ☐ Field Service
- ☐ Technical Writing
- ☐ Sales

In the field of:

- ☐ Military Radar, Sonar, or Communication
- ☐ Electronic Components
- ☐ Commercial Television
- ☐ Tubes
- ☐ Semiconductors

ELECTRONIC ENGINEERS

Experienced in microwave techniques for long-range project involving unusual radar applications. The positions offer opportunity to work in the field of very high microwave problems including transmission in wave guides, in antenna design and associated high frequency equipment.

These positions are in the Principal Engineer level.

Other positions are open for electronic engineers in the development of guidance components for guided missile systems.

Electronic engineers are needed at all levels in other assignments such as radar-aeronautical systems, electromechanical instrumentation and servomechanisms.

CORNELL AERONAUTICAL *Laboratory, Inc.*
4352 GENESEE ST. BUFFALO 21, N. Y.

TRANSLATORS
Native English speaking
From French, German, Spanish, Italian, Russian in fields of communications, electricity and electronics. Send sample translation with resume, with emphasis on science rather than language.
P9527, Electronics
330 W. 42nd St., New York 36, N. Y.

COMPUTER
Applications and Development

ENGINEERS

COMPUTING SERVICES
Engineering & Scientific Computation
Analog
Digital

COMPUTERS SYSTEMS DEVELOPMENT

DEVELOPMENT
Analog and Digital
Systems analysis and synthesis
Logical organization
Circuit design

These are full time positions offering fascinating and varied work and educational benefits for graduate study. Contact:

J. A. Metzger
ARMOUR RESEARCH FOUNDATION
of Illinois Institute of Technology
10 West 35th St. Chicago 16, Illinois

GOING OUR WAY?

ENGINEERS and PHYSICISTS are going one direction at MOTOROLA . . . UP!

We, at Motorola, know where we're going—and we're confident about getting there. If you, too, believe there's plenty of room at the very top—why not join us? You'll be teaming up with men of vision in an organization that respects creativeness as well as hard work. We think you'll grow with the challenging assignments at Motorola—missile guidance, radar, microwave, and the many other pioneering projects.

Motorola's continuing expansion program offers excellent opportunity for advancement to match your abilities. But, just as important to an engineer or physicist, the daily challenge to the imagination will bring the strong sense of accomplishment you seek.

If you're an electrical engineer, mechanical engineer, or physicist (senior or junior level), and looking for more important assignments in:

CHICAGO, ILLINOIS

Two-Way Communications
- Receivers and Transmitters
- Power Supply
- Antenna design
- Systems Engineering

Microwave
- Pulse Circuit Design
- Systems Design
- Circuit Design

Military Communications
- Receiver and Transmitter Design
- Circuit Design
- Antenna Design
- Radar Design

Field Engineers
- Microwave Maintenance
- Airborne Radar

PHOENIX, ARIZONA
- Microwave Antennas
- Transmitters and Receivers
- Modulators
- Pulse and Video Circuitry
- Environmental Test
- Packaging of Missile Borne Electronic Equipment
- Radar Systems Design
- Logical Circuitry
- Servo Mechanisms
- Transistor Applications
- Electro-Mechanical Devices

RIVERSIDE, CALIFORNIA *(65 miles from Los Angeles)*
- Military Operation Analysis
- Dynamics Analysis
- Analog Computor Operations
- Digital Computor Analysis
- Digital Computor Design
- Circuit Design
- Microwave Systems
- Servo Mechanisms
- Airborne Electronics
- Aerophysics

For Assignments with a FUTURE UNLIMITED write:

MOTOROLA, INC.

Engineering Personnel Mgr., **4501 W. Augusta Blvd., Chicago 51, Illinois**

TECHNICAL OPERATIONS, INC.

INVITES INQUIRIES FROM ELECTRONIC ENGINEERS INTERESTED IN JOINING A MODERATE SIZED RESEARCH AND DEVELOPMENT ORGANIZATION OPERATED BY SCIENTISTS FOR SCIENTISTS.

IF YOU ARE INTERESTED IN A FUTURE LIMITED ONLY BY YOUR OWN ABILITY, PLEASE CONTACT

Robert Smyth
Technical Operations, Inc.

6 Schouler Court
Arlington 74, Mass.

Experienced Electronics Writers...

Immediate Openings at AUTONETICS

For writers who can prepare trouble analyses, check-out and line-maintenance procedures for service handbooks on electronics equipment. Practical experience desired in laboratory or field work in radar, computers, receivers and transmitters.

Please write immediately to:

D. S. Grant
Engineering Personnel Office, Dept. 991-20E,
12214 Lakewood Boulevard, Downey, California

Autonetics
A DIVISION OF NORTH AMERICAN AVIATION, INC.

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

— RATES —

DISPLAYED

The advertising rate is $21.50 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column — 3 columns — 30 inches to a page.

Subject to Agency Commission.

UNDISPLAYED

$2.10 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers—counts as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS to ELECTRONICS, 330 W. 42nd St., N. Y. 36, N. Y. for May issue closing April 2nd

EMPLOYMENT OPPORTUNITIES

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)
LOS ANGELES: 1125 W. 6th St. (17)

POSITIONS VACANT

Instructor or Assistant Professor in electrical engineering: to teach laboratory and lecture courses in circuits, machines and either electronics or power; M.S. degree plus industrial experince required. Good opportunity for advancement in a new department in the process of planning a new building and curricula. Good salary scale. Appointment open September, 1956. Write E. B. Weinberg, Sacramento State College, Sacramento, California.

Wanted Resister engineer with experience in the manufacture of ceramic based printed circuits by large eastern manufacturer. Salary open, commensurate with ability and experience. All replies held in strictest confidence. Please reply to P-1064, Electronics.

Engineers—High frequency heating. Design or sales experience with dielectric or induction heating equipment or power oscillators preferred. Expanding medium size company within 30 miles of New York has challenging opportunities for technicians, draftsmen and engineers. Send brief resume. P-1089, Electronics.

SELLING OPPORTUNITY OFFERED

Manufacturer's Representatives — Custom Plastics electronic parts fabrication. Expanding Eastern custom fabricators and machinists (automatic screw) of plastic parts—stampings, terminal board assemblies, connectors, insulation—from Teflon, Rexolite, Nylon, laminated phenolics, etc. Need reps with active contacts and experience in electronics industry. Attractive commissions—protected territories. Send data on experience and territories. RW-1049, Electronics.

POSITIONS WANTED

Electron Tube Engineer. Now serving in executive capacity. Wide experience in development and research. Background cathode ray, color, photo sensitive, fluorescent, thyratron, high vacuum, etc. Glass and metal techniques. PW-1044, Electronics.

Technical Editor, 4 years industrial experience with handbooks for complex electronic system on govt. contracts, desires responsible position in the New York City area. PW-9373, Electronics.

SELLING OPPORTUNITIES WANTED

Established Metropolitan New York salesman seeks component lines for manufacturers and industrials. Please reply to RA-8897, Electronics.

Additional items wanted on exclusive factory representation in State of California. Now selling remote control for TV. Lane-Leeds Industries, 1310 Santee St., Los Angeles 15, California.

Position wanted in

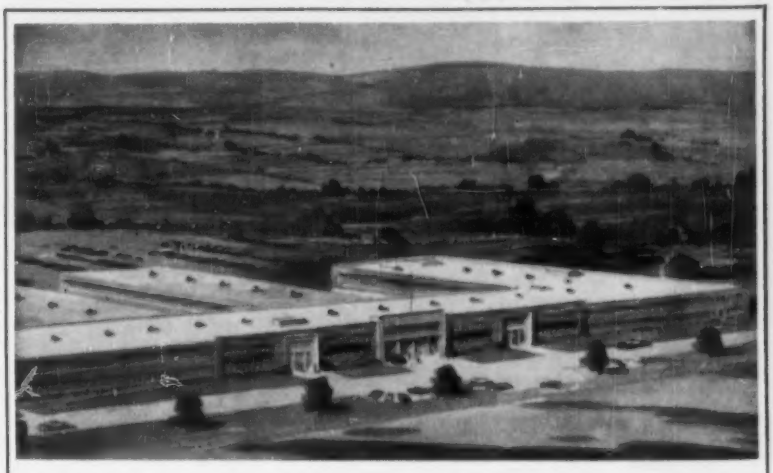
NEW PRODUCTS DIVISION

of Progressive Firm actively engaged in design, developing and marketing new electrical, electromechanical and electronic products. Experience: 6½ yrs college, 5 yrs industrial, 3 yrs teaching, patent history. Salary $8500-$11500, advancement based upon results.

PW-9528, Electronics
330 W. 42nd St., New York 36, N. Y.

When Answering
BOX NUMBERS . . .

to expedite the handling of your correspondence and avoid confusion, please do not address a single reply to more than one individual box number. Be sure to address separate replies for each advertisement.



Raytheon's new Wayland Laboratory is devoted exclusively to the design and development of advanced electronic equipment. Under one roof an engineer can see his program carried through completely . . . from idea to reality.

A delightful location—only 17 miles from the heart of Boston—offers a choice of rural or urban living, and access to the entire New England area is convenient via a network of modern highways.

Positions are available for

Engineers and Physicists

experienced in the Systems Analysis and Design of Radar equipment

For further details, send your name and address to
MR. ROBERT E. DOHERTY AT:

RAYTHEON MANUFACTURING COMPANY
WAYLAND LABORATORY
WAYLAND, MASSACHUSETTS

*** No resume required—we will send you a brief form which can be completed in just a few minutes.**

Excellence **RAYTHEON** *in Electronics*

ENGINEERS
DESIGNERS
TECHNICIANS

Investigate Opportunities at

ERCO DIVISION
OF ACF INDUSTRIES INC.

ERCO Engineers have built a record of continuous progress and growth for themselves and for the Company for a quarter of a century . . . growth in physical plant, personnel, number and diversity of products and services.

Today this growth continues and we are constantly on the alert for new men to add fresh impetus to that progress . . . paying top salaries to capable people.

Your work will be interesting and stimulating . . . it might include electronic flight simulators, machine tools, guided missiles, or a variety of specialized electronic devices.

You can choose a home from a number of fine nearby residential areas convenient to both shopping centers and plant . . . and you can further your education at the many nearby Universities . . . you can enjoy suburban living and be within easy reach of the cultural advantages of the Nation's Capital.

ERCO now needs Electronic Engineers (all levels with some overseas positions available). Aerodynamicists, Analog Computer Engineers, Mechanical Design Engineers, and supporting personnel. Send resume or request for additional information to:

ERCO DIVISION
OF ACF INDUSTRIES
RIVERDALE • MARYLAND

SEMICONDUCTOR DEVELOPMENT

Responsible positions are now available with one of the leading and fastest growing manufacturers of semiconductors. These are outstanding opportunities for Physicists and Engineers in research, development or applications of advanced silicon and germanium transistors, rectifiers and diodes.

Positions are available for:

Physicists
Device Engineers
Electrical Engineers
Application Engineers

Send resume or call

Transitron electronic corporation
407 Main Street *MElrose 4-9600* Melrose, Mass

RADIO ENGINEER

LARGE MIDWESTERN CONCERN HAS EXCELLENT OPENINGS FOR TOP FLIGHT RADIO ENGINEERS WITH TRANSISTOR EXPERIENCE FOR AUTOMOTIVE RADIOS. SALARY COMMENSURATE WITH PAST EXPERIENCE. LIBERAL FRINGE BENEFITS AND EXCELLENT WORKING CONDITIONS. SUBMIT COMPLETE RESUME GIVING DETAILS OF PAST EXPERIENCE AND EDUCATIONAL BACKGROUND.

P9544 Electronics, 520 N. Michigan Ave., Chicago 11, Ill.

McGRAW-HILL MAILING LISTS WILL HELP YOU

- Merchandise your advertising
- Conduct Surveys
- Get leads for your salesmen
- Get inquiries about your product or service
- Pin-point geographical or functional groups
- Sell Direct
- Build up weak territories
- Aid Dealer Relations

Direct Mail is a necessary supplement to a well rounded Business Paper Advertising program.

600,00 actual names of the top buying influences in all the fields covered by the McGraw-Hill publications make up our 150 mailing lists. These lists are built and maintained primarily for our own use, but they are available to you for Direct Mail purposes. Pick out a list of YOUR prospect from our Industrial Direct Mail Catalogue.

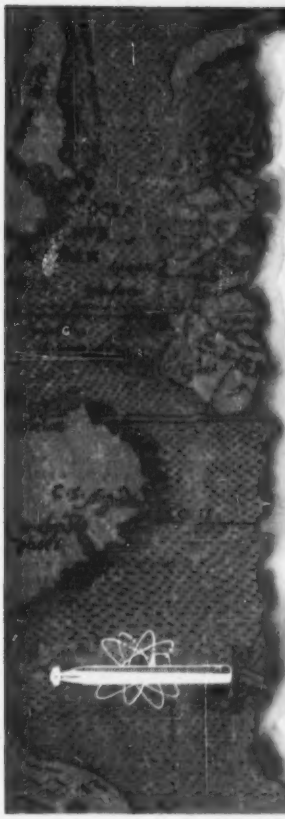
More and more, progressive companies are using Industrial Direct Mail regularly as an advertising medium. They effectively allocate a portion of their concentrate on the *best* business publication.

For complete, detailed information about our service, fill in the coupon or write for your copy of our free Business and Industrial Direct Mail catalogue.

Direct Mail Division,
McGraw-Hill Publishing Co., Inc.
330 West 42nd St., N. Y. 36, N. Y.

Please forward my free copy of the McGraw-Hill "Industrial Direct Mail Catalogue."

Name _____
Company _____
Address _____
City _____ State _____



ELECTRICAL ENGINEERS:

A Career at Electric Boat... Is An ADVENTURE in Engineering

In the past several years, Electric Boat has been making one headline after another as the nation's first adaptor of nuclear power for propulsion. The Electric Boat-designed and built atom submarines, Nautilus and Seawolf, are already accomplished fact.

Behind the headlines, the work of designing even more advanced atomic submarines goes on. Every day, Electric Boat engineers are coming to grips with problems in nucleonics that pave the way for applications in other fields.

There is room — and opportunity — for more engineers able to cope with these problems. Current openings are for Electrical Engineers versed in servo-mechanisms, circuitry, motors and generators, radar and sonar, or electro-mechanical systems.

These jobs offer more than engineering adventure. There's common-sense practicality involved, too. Electric Boat's backlog of orders and years-ahead plans; its record stable engineering employment; its sponsorship of advanced study at leading universities and within the plant are some of the practical features. New England living on the shores of Long Island Sound is another.

To find out more details about these opportunities, write us details of your background and experience including initial salary requirements. Interviews will be arranged promptly for qualified applicants. Please address **Peter Carpenter.**

ELECTRIC BOAT

DIVISION OF GENERAL DYNAMICS CORPORATION
GROTON, CONNECTICUT

ENGINEERS SCIENTISTS

Make More Money —Improve Your Position

DECISION/INC is retained by leading manufacturers and research firms in all sections of the country. *Our clients pay us to find you!* No obligation to you—no cost whatsoever. Completely confidential.

All you have to do is send us your name, type of work, company and home address. We will forward brief forms to your *home*. We will then present to you various openings in diversified companies from which you can choose the one you like best.

If you would like to know what you're *really* worth, write, phone or wire us *now!*

DECISION/INC
Management and Recruitment Consultants
Oliver P. Bardes, President

444 FIRST NATIONAL BANK BUILDING
CINCINNATI 2, OHIO

ELECTRONICS ENGINEERS

Experienced in design of electronic circuits, radio frequency, DC and video amplifiers, pulsers and IF amplifiers, electronic control circuits for gating and limiting, magnetic relays.

PHYSICISTS

Industrial or laboratory experience. Knowledge of wave motion in solids, sonar techniques, seismology, acoustics or ultrasonics.

ULTRASONICS . . . . . Key to your future success

Here is an industry which has just crossed a threshold of unlimited possibilities. Together with electronics, it is America's fastest growing industry, and Sperry Products, Inc. is a recognized leader in the field. To keep pace with expanding markets, Sperry has openings for engineers and physicists in its continuing development progam.

Here are creative opportunities to develop new ultrasonic products and new applications for existing products with this long established company.

These are permanent positions with an organization that has always emphasized long term non-defense objectives. With Sperry Products, Inc. you gain outstanding company benefits, a high salary commensurate with your abilities, and relocation expenses to the charming Connecticut county of Fairfield. Please send complete resumes in confidence to P. J. Olivo. Convenient interviews will be arranged.

SPERRY PRODUCTS, INC.

DANBURY, CONNECTICUT

Immediate openings in Oster's expanding *avionic division*

- ***system engineers*** . . . for development of airborne electro-mechanical systems. Includes indicators, servo-mechanism devices, transistorized amplifiers and computers. Experience with servos utilizing electrical and electro-mechanical components desirable.
- ***project engineers*** . . . experienced in design of MIL-type synchros, resolvers, motor generators, gyros, and electro-mechanical actuators.
- ***designers*** . . . experienced in electronic and electro-mechanical packaging of flight instruments utilizing sub-miniature components and techniques associated with servos, amplifiers and gear trains.

Top income . . . excellent advancement opportunities . . . complete facilities . . . interesting creative work on advanced design in control problems of jet aircraft systems.

Enjoy a permanent position. Oster is a recognized industry leader, but not so big that you get lost. Make your home in friendly Racine . . . on the shores of beautiful Lake Michigan . . . ½ hour from Milwaukee, 1 hour from Chicago . . . convenient to Wisconsin's famous North Woods resorts.

You are invited to send details of your background to our Director of Research and Special Products preliminary to confidential interview.

John Oster MANUFACTURING CO.
avionic division
RACINE, WISCONSIN

ELECTRONIC DEVELOPMENT ENGINEERS

Challenging DESIGN & DEVELOPMENT POSITIONS for CREATIVE ENGINEERS

These positions are tailor-made for highly imaginative engineers who enjoy problems of more than ordinary difficulty; problems that require a maximum of individual electronic creativity. Men selected will be entrusted with the complete electronic or electro-mechanical design and development tasks (initial circuits, systems, components, or product design) entailed in carrying a prototype project from original conception to its completion

REQUIREMENTS: Senior and intermediate engineers with degrees and 4 to 8 years' experience; Junior engineers with degrees and 1 to 3 years' experience, capable of growing with our long-range, electronic design and development program in the following fields:

(1) ANALOG COMPUTER
(2) RADAR BEACONS
(3) MAGNETIC AMPLIFIERS
(4) ELECTRO-OPTICS
(5) MISSILE SYSTEMS
(6) SERVOS
(7) FIRE CONTROL SYSTEMS

WE ARE LOCATED in a suburban area, at the Paramus exit of Garden State Pkway., convenient to the N. J. Turnpike and only 15 minutes from Manhattan. If you choose, you can live nearby, avoiding the discomforts, costs and time wasted in commuting. Enjoy living in a clean, friendly community, minutes from work!

Interviews will be arranged at convenient locations. Send resume to:

AVION DIVISION
OF ACF INDUSTRIES INCORPORATED
Route 17, Paramus, N. J. COlfax 1-4100
Only 15 minutes from George Washington Bridge

DO YOU NEED ENGINEERS WITH EXPERIENCE IN:

- Research
- Development
- Design
- Instrumentation
- Servomechanisms
- Missiles
- Audio Systems
- Control Systems
- Radar
- Computers
- Transistors

Place an "ENGINEERS WANTED" advertisement in this SEARCHLIGHT SECTION of ELECTRONICS. It's an inexpensive, time saving method of selecting competent personnel for every engineering job in the electronics industry. The selective circulation of ELECTRONICS offers you an opportunity to choose the best qualified men available throughout the industry.

For Rates and Information Write:

CLASSIFIED ADVERTISING DIVISION
McGRAW-HILL PUBLICATIONS
330 West 42nd St.,
New York 36, N. Y.

WHAT IS

ELECTRONIC ENGINEERS

build a career in controls at KEARFOTT

Kearfott has made some outstanding advances to improve the performance and reduce the size of airborne control components and systems... and Kearfott is growing fast. Here you can advance, while enjoying original and creative assignments.

Another factor which makes rapid promotions possible is Kearfott's decentralization which allows closer management contact and recognition of achievement. The 7 plants in the Passaic-Clifton-Paterson area of northern New Jersey are autonomous, each one a fully integrated unit. This means you get small-company congeniality and flexibility along with the benefits, resources and modern facilities of a large and progressive organization. There's top remuneration, too, at Kearfott, AND a long range future.

An important member of the widely diversified General Precision Equipment Corporation, Kearfott since 1947 has been a leader in the design and development of precision instruments for industry and the armed services. This leadership gives you opportunity to be in on the most advanced work, to grow in professional stature.

Design and Development Positions Available on several levels of responsibility in the following areas of interest: servo systems, test equipment, servo-mechanisms, gyro systems, computing systems, servo and magnetic amplifiers, electronic circuit design, attitude sensing systems and transisterization.

Also Positions Bearing Project Responsibility for design and development of static and dynamic packages.

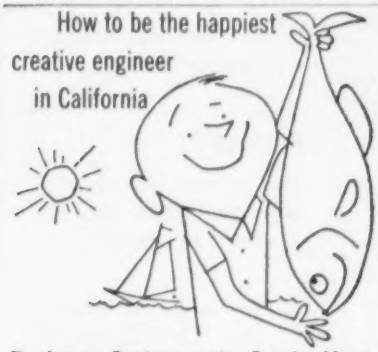
Plan your career in controls today—
send complete details to **James E. Butler**

Kearfott COMPANY, INC.

1378 Main Ave.,
Clifton, New Jersey

Subsidiary of General Precision Equipment Corporation

How to be the happiest creative engineer in California



Beckman Instruments, Inc.* offers E.E.'s, M.E.'s, Manufacturing, and Sales Engineers the kinds of jobs that creative men dream about. Top salary, all employment "extras" including our Educational Assistance Plan, modern facilities and personal recognition that comes naturally with our decentralized operation. Small town living... but near metropolitan areas in either Fullerton, So. Pasadena, Newport Beach, Richmond or Palo Alto.

*We're pacing the commercial electronics field ($3,000,000 sales in 1949 to $21,000,000 sales in 1955) and we'll be disappointed if you don't grow with us.

Beckman / *instruments, inc.*

Write Beckman Instruments, Inc., 2999 W. 6th St., Los Angeles 5, Calif. Ask for Career File #52

EXCELLENT OPPORTUNITIES FOR ENGINEERS & SCIENTISTS

IN RESEARCH AND DEVELOPMENT OF INSTRUMENTS & EQUIPMENT

QUALIFICATIONS:

BS, MS or PhD degrees in mechanical, electrical, electronics and chemical engineering, physics and chemistry.

A CAREER WITH A FUTURE:

Permanent, responsible positions for qualified, creative men to develop, design and apply special instruments and equipment for our pilot plant and process operations.

EMPLOYEE BENEFITS:

Excellent working conditions, modern facilities, Retirement and Insurance Programs, Company Supplemented Savings Plan.

GOOD LOCATION:

Modern, medium sized Southwestern community. Pleasant surroundings with excellent family recreation, religious and educational facilities.

Reply by letter giving age, experience and other qualifications. All applications carefully considered and kept strictly confidential. Write:

Industrial Relations Manager
Research and Development Department
PHILLIPS PETROLEUM COMPANY
Bartlesville, Oklahoma

IMMEDIATE OPENINGS

SYSTEMS ENGINEERS

For development, testing and field service of airborne navigational systems. Some experience with servos utilizing electronic and electro-mechanical components desirable.

ELECTRICAL ENGINEERS

Experience in small electro-mechanical devices, motors, synchros and induction pick-offs.

FIELD SERVICE ENGINEERS

For work associated with airborne navigational equipment. Should be versed in electronics circuitry and mechanical repairs. Entails some travel.

DESIGNERS

Electronic, Electro-mechanical, Mechanical

1. Electronic and electrical packaging. Knowledge of sub-miniaturized techniques. Work is associated with servos, amplifiers and components.
2. Mechanical or electro-mechanical packaging of precision flight instruments.

As designers of America's finest aircraft instruments, Kollsman can provide excellent opportunity for professional growth. And the congenial atmosphere, the modern facilities contribute to an environment in which a man can do his best work.

Please submit resumes to the Employment Manager. Confidential interviews will be arranged.

kollsman INSTRUMENT CORPORATION

80-06 45th AVENUE, ELMHURST, NEW YORK • SUBSIDIARY OF Standard COIL PRODUCTS CO. INC.

• RADIO COMMUNICATION SYSTEMS • INFRARED • DIGITAL TECHNIQUES • DATA SYSTEMS

SENIOR and INTERMEDIATE ELECTRONIC ENGINEERS

Stromberg-Carlson, a Division of General Dynamics Corporation, is located in the Finger Lakes region of upstate New York. In addition to providing a wide variety of challenging engineering opportunities, excellent salaries are offered with the finest working conditions in a modern electronics laboratory. Unusual recreational and educational facilities are available in this medium-sized progressive city, and fine residential areas are located within a mile of the plant. Because of the variety of its product line, which is approximately equally divided between military and civilian, Stromberg-Carlson offers a degree of stability and an opportunity for advancement unequalled in the industry. Openings:

Radio Communication Systems **Data Systems** **Digital Techniques**
Microwave Circuits **Mechanical Design Engineering** **Infrared**
Automatic Test Systems **Countermeasures** **Navigational Systems**
Military Transistor Applications **Radar** **Missile Guidance Systems**

Write or call collect:

C. W. Finnigan, Chief Electronics Engineer

STROMBERG-CARLSON COMPANY

A DIVISION OF GENERAL DYNAMICS CORPORATION

104 CARLSON ROAD, ROCHESTER 3, N. Y.

• RADAR • RADIO COMMUNICATION SYSTEMS • MISSILE GUIDANCE SYSTEMS • DATA SYSTEMS

• MICROWAVE CIRCUITS • MECHANICAL DESIGN ENGINEERING • NAVIGATIONAL SYSTEMS

• AUTOMATIC TEST SYSTEMS • MILITARY TRANSISTOR APPLICATIONS • COUNTERMEASURES •

WHAT IS YOUR PROBLEM?

PERSONNEL?

Do you need competent men for your staff? Do you need men to fill executive, sales or technical positions?

EMPLOYMENT?

Are you one of the readers of ELECTRONICS seeking employment in any of the above capacities?

BUSINESS OPPORTUNITIES?

Are you looking for or offering a business opportunity of special interest to men in the field served by this publication?

EQUIPMENT?

Do you need equipment—Used or Surplus new? Do you have any to offer?

Read the Searchlight Section, and the "EMPLOYMENT OPPORTUNITIES" Section found in every issue of ELECTRONICS for the solution of these problems. Or bring your problem directly to the attention of other readers. You can get their attention—and action—at a relatively low cost by placing your ad in

ELECTRONICS

330 West 42nd St., N. Y. 36

EMPLOYMENT OPPORTUNITIES

Employment Opportunities
ADVERTISERS INDEX

Admiral Corp. 452
American Machine & Foundry Co. 462
Arma Div., American Bosch Arma Corp. .. 487
Armour Research Foundation of Illinois Institute of Tech. 470, 479
Avion Div. of ACF Industries, Inc. 484
Autonetics Div., of North American Aviation, Inc. 480

Beckman Instruments, Inc. 485
Beech Aircraft Corp. 477
Bell Aircraft Corp. 469
Bendix Aviation Corp.,
Pacific Div. 456
Products Div., Missile Section 451
York Div. 467
Blonder-Tongue Labs. 466
Burroughs Research Corp. 471

Collins Radio Co. 450
Communication Accessories Co. 475
Convair, A Div. of General Dynamics Corp.,
Pomona, Calif. 477
San Diego, Calif. 457
Cook Research Laboratories 478
Cooper, J. J. 472
Cornell Aeronautical Lab, Inc. 479

Davies Laboratories, Inc. 460
Decision, Inc. 483
Drake Personnel, Inc. 472

Electric Boat Div., General Dynamics Corp. 483
Electronic Eng. Co., of Calif. 464
Erco Div., of ACF Industries 482
Farnsworth Electronics Co. 450

General Electric Co., Syracuse, N. Y. . 464, 478
General Motors Corp., AC Spark Plug Electronics Div. 461
Goodyear Aircraft Corp. 449

Haynes, Palmer, Ann 472
Honeywell Brown Instruments 453

Industrial Research Labs. 452
Instruments for Industry, Inc. 452

Johns Hopkins University
Chevy Chase, Md. 470
Silver Spring, Md. 466

Kearfott Co., Inc. 485
Kollsman Instrument Corp. 486

Lear, Inc. 462
Librascope Inc., General Precision 476

Magnavox Co. 488
Maryland Electronic Manufacturing Corp. 458
Melpar, Inc. 487
Minnesota, University of 472
Missile Test Project 460
Monarch Personnel 472
Motorola, Inc. 479

National Cash Register Co.,
Dayton, Ohio 463
Hawthorne, Calif. 466

Oster Mfg. Co., John 484

Page Communications Engineers, Inc. 477
Phillips Petroleum Co. 485

Radio Corp. of America 454, 455
Raytheon Mfg. Co.,
Bedford, Mass. 465
Newton, Mass. 453
Waltham, Mass. 447, 468, 472
Wayland, Mass. 481
Republic Aviation Corp. 474

Sperry Products Co. 483
Stavid Eng. Co. 448
Stromberg-Carlson Co., Div., of General Dynamics Corp. 473, 486
Sylvania Electric Products,
Buffalo, N. Y. 448
Mountain View, Calif. 458
Waltham, Mass. 448
Woburn, Mass. 464

Technical Operations 480
Texas Instruments, Inc. 470
Transitron Electronic Corp. 488
Trans World Airlines 488
Tung-Sol Electric, Inc. 456

Varian Assoc. 468

Zenith Radio Corp. 459

This index is published as a convenience to the readers. Care is taken to make it accurate but CLASSIFIED assumes no responsibility for errors or omissions.

ENGINEERS
Electronic *Mechanical*

There's room to... GROW AT MELPAR

Currently we seek men with experience in one or more of the following:

- Network Theory
- Systems Evaluations
- Microwave Technique
- UHF, VHF, or SHF Receivers
- Analog Computers
- Magnetic Tape Handling
- Digital Computers
- Radar and Countermeasures
- Packaging Electronic Equipment
- Pulse Circuitry
- Microwave Filters
- Flight Simulators
- Servomechanisms
- Subminiaturization
- Electro-Mechanical Design
- Small Mechanisms
- Quality Control and Test Engineers

More and more these days you hear top engineers talk about the many growth opportunities at Melpar. With an increasing number of significant electronic projects, an enlarged staff and facilities, Melpar provides many opportunities for professional growth and advancement. Our new laboratory is an engineer's dream come true; a building conceived by and constructed for the ENGINEER – 265,000 sq. ft. of complete engineering facilities.

We are located in Fairfax County of northern Virginia where housing is reasonable and plentiful—whether you desire a private home or an apartment. Although we are in a truly suburban atmosphere, we are only 10 miles from the nation's capital with all its recreational and social advantages. Here you and your family can grow in an environment to match your professional growth.

Send resume to Technical Personnel Representative,

melpar, inc.
A subsidiary of the Westinghouse Air Brake Co.
3000 Arlington Blvd., Dept. E-28 Falls Church, Va.
11 Galen Street, Watertown, Mass. • 99 First St., Cambridge, Mass.

ENGINEERS

ARMA pioneers in

INERTIAL NAVIGATION

Immediate openings for Supervisory and Staff *positions as well as for*

Senior Engineers, Engineers, *and* Associate Engineers, *experienced in:*

SYSTEMS EVALUATION
GYROSCOPICS
DIGITAL COMPUTERS
ACCELEROMETERS
TELEMETRY
GUIDANCE SYSTEMS
STABILIZING DEVICES
SERVOMECHANISMS
AUTOMATIC CONTROLS
THERMODYNAMICS
OPTICS
ENVIRONMENTAL RESEARCH
TRANSFORMERS

ARMA, recognized for its accomplishments in the fields of navigation and fire control, is a leader in the development of Inertial Navigation. This new system deals solely with space, time and acceleration . . . acting independently of external influences.

Creative engineering of the highest order is required to develop components making Inertial Navigation possible; *accelerometers* to measure acceleration; *integrators* to convert this information into velocity and distance; *gyros* to provide directional reference and hold the system stable; *computers* to calculate course-to-steer and distance-to-go. Components must meet rigid weight and size requirements . . . and function with undreamed-of accuracy.

ARMA, one of America's largest producers of ultra-precise equipment, offers unlimited opportunity for engineers to help in this great endavor. Challenging projects and ARMA's extensive supplementary benefits make an ARMA career doubly attractive. ARMA engineers are currently working a 48 hour week at premium rates to meet a critical demand in the Defense Dept's missile program.
Moving allowances arranged.

Send resume to:

ARMA
Technical Personnel Dept. 2-500
Division of American Bosch Arma Corporation
Roosevelt Field, Garden City, Long Island, N. Y.

Where in the World do You Want to Go in Your ENGINEERING CAREER?

If you are seeking an opportunity to further your career with a fine company . . . look no further.

TWA presently has openings for Aeronautical, Mechanical, Electrical and Electronic Engineers to work with a small, select group of engineering associates. This arrangement gives each engineer the opportunity to demonstrate his ability and to advance within the company . . . the opportunity to build his future with the world's finest airline.

Qualifications: B.S. in Engineering.
Location: TWA's ultra modern building now nearing completion at Kansas City, Mo.

Living Conditions: Excellent, both city or suburban private homes or apartments.

Benefits: Many employee benefits, including liberal free transportation for yourself and family each year.

Salary: Commensurate with experience.

If you are an engineer with qualifications in any of these fields explore *your* opportunity with TWA today. Write:

Mr. R. Paul Day, Employment Manager

TRANS WORLD AIRLINES
Kansas City 5, Missouri

electronic & mechanical
engineers

NEW Opportunities in Fort Wayne as Magnavox Continues to Grow

Integrity, leadership, bold concepts . . . these have made Magnavox the significant name it is in the world of commercial television and military electronics. And the rewards at this company are many, based on our constant growth and expansion in the field of electronics.

An important way of life goes with Magnavox in Fort Wayne . . . because this community and its facilities and resources have earned for it the title of "The Happiest City in the United States" according to Look Magazine.

Career positions now open in:
TELEVISION DESIGN • TEST PROCESS
TEST EQUIPMENT • ASW AND COMMUNICATIONS
MILITARY PUBLICATIONS • AIRBORNE RADAR

Please forward complete resume to
Mr. Richard Parvin

THE MAGNAVOX CO.
FORT WAYNE 4, INDIANA

INDEX TO THE SEARCHLIGHT SECTION ADVERTISERS

Allied Electronics Sales..... 500
Alltronics 489
Arrow Sales, Inc..... 494

Barry Electronics Corp..... 499
Blan 498

C & H Sales Co..... 493
Communications Equipment Co..... 491

Diamond Metal Co., Inc..... 499

Electronicraft Inc. 498
Empire Electronics Co..... 498
Engineering Associates 501

Fair Radio Sales..... 494
Fay-Bill Distributing Co..... 496
Finnegan, H. 498

Greene, G. 496

Harjo Sales Co..... 489

Instrument Service Co..... 501
JSH Sales Co..... 495

Lectronic Research Labs..... 489
Legri S. Co., Inc..... 489
Leru Laboratories Inc..... 501
Liberty Electronics Inc..... 492

McNeal Electric & Eqpt. Co..... 489
Monmouth Radio Labs..... 492
M. R. Co., The..... 501

Radalab Inc. 494
Radio & Electronic Surplus..... 496
Relay Sales 499
Rex Radio Supply Co..... 499
Ruxur Electronics 490

Sagal Co., Leo..... 492
Servo-Tek Products Co..... 500

"TAB" 502

Universal General Corp..... 497

V & H Electronic Industries..... 498
V & H Radio & Electronics Supply... 489

Western Engineers 490
Wilgreen Industries 490
Wolf Co., Edward..... 501

This index is published as a convenience to the reader. Care is taken to make it accurate but Classified assumes no responsibility for errors or omissions.

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

UNDISPLAYED RATE

$2.10 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS, $2.10 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED RATE

The advertising rate is $18.50 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page.

EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

Send NEW ADVERTISEMENTS to N. Y. Office, 330 W. 42nd St., N. Y. 36, N. Y. for May issue closing April 2nd

The publisher cannot accept advertising in the Searchlight Section, which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

POLYSTYRENE CAPACITORS

1% TOLERANCE
200 VDCW 500 VDCT
Hermetically Sealed

0.5 MFD. . . . . $7.50 ea.
1.0 MFD. . . . . $12.10 ea.

Immediate Delivery

SYNCHROS

ALL TYPES IN STOCK
Immediate Delivery

LECTRONIC RESEARCH LABS.

715-19 Arch Street
Phila. 6, Pa. Phone MA-7-6771

GLASS INFRA-RED FILTERS

Special Designed Filter When Placed In Front Of Any Light Source, Filters Out All Visible Light But Freely Passes Invisible Infra-Red Rays. Army Snooperscope Part #A-1529. 5-⅝" Dia. By ⅛" Thick. BRAND NEW. Package Of Ten Filters For ONLY $10.00

LOW-VOLTAGE TRANSFORMERS

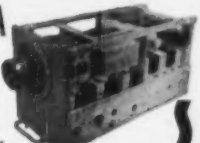
New Release of Government Surplus Material

Model #8-9527, KENYON TRANSFORMER CO. — 2.2 KVA. Input 110/220 volts 50/60 Cy. Output 11 Volts C-T (5.5-0-5.5) At 200 Amperes! Continuous Duty. Case Size 8½ x 10¼ x 13". Price BRAND NEW ONLY . . . . . $35.95 Ea. #8-9527-WE. WESTINGHOUSE — Same Specs. But Single 115 V Input & Lighter Wt. NEW $21.95

Terms: Prices FOB St. Louis. Cash With Orders. Well Rated Concerns (D&B) Net 10 Days Cash.

McNEAL ELECTRIC & EQUIPMENT CO.
4736 Olive St. Dept. E-4, St. Louis 8, Mo.

RCA TV CAMERA



NEW Surplus
for Labs! Export! Industrials! Medicine! Closed Circuit TV!

Ideal for labs, industry, prisons, TV technicians, swim pools, medics—"mechanical eye" for closed circuit TV. 1846 Iconoscope, 6-stage video amplifier and clipper. THE REAL THING! Send for new, free, complete technical data. SOLD AT FRACTION OF REAL VALUE!

Harjo Sales Co.
Office-Warehouse: Dept. E-4, 803 N. Victory Blvd., BURBANK, CALIFORNIA

ART-13 APR-4 BC-610-E

BC-348, BC-312, BC-342, TCS, BC-221, TS-173, ARC-1, APR-5AX, RTA-1B
FRA Teletype Converters (RCA)

ALLTRONICS,
Box 19, Boston 1, Mass. *Richmond 2-0048*

ELECTRONIC TUBES — All types — one dependable source!

ALL V. & H. TUBES . . . . are new, first quality, unconditionally guaranteed! . . . advertised here are in stock—now! . . . are standard brands, R.C.A., Sylvania, G.E., etc. . . . are obtainable from one source. That includes NATO, JAN, commercial, special purpose, transmitting, receiving, etc.

OA2	1N73	2J61A	4J32	6BK7W	2D21WTH,TL	572AX	870	6642	6896
OA3/	1N76	2J62A	4J50	6BL7W	2G21A	574AX	870	6643	6897
VR75	1N78	2K22	4P-R60A	GT	2G51A	575A	870	6644	6903
OA4	1N81	2K25	4X-150A	6BN7W	2J26A	861	872	6645	6905
OA5	1N91	2K26	4X-150G	GT	2J55A	866	872A	6646	6912
OB2	1N92	2K26	4X-250B	6BJ27	2J60B	RU627	884	6647	6913
OB2WA	1N93	2K28	4X-500A,	GTY	2J62B	931-P	885	6648	6914
OB3/	1N126	2K29	F	6X4W	QK264	645-P1	885RA	6655WA	5948
VR90	1N127	2K30	C5B	7AK7	2N0A	HK654	891	6656	5949
OB4	1N128	2K31A	EL5B	7BP7, A	HF100	700B	892	6657	5950
OC3/	1N158	2K39	5AP1	7CP1	100B	705A	892R	6659	5951
VR105	1N198	2K45	5BP1	7VP7	1048, L	706A	893A	6660	5961
OD3/	1P21	2K42	5BP4	7YP2	TH, TL	706A	896A	6661	5977
VR150	1P24	2K43	5C22	8D21	GG105	706	902P1	6662	5980
OD3W	1P30	2K44	5CP1	9LP1	CE100	SERIES	920	6663	6001
OZ4	1P31	2K45	5CP2A	9LP7	707A	707A, B	921	6670	6002
RL1	1P32	2K46	5CP7	10E/22	710A	708A	925	6677	6003
1A2D	1P36	2K47	5D21	10K/222	711CT	710A	930	6678	6004
6G1A4B	1P37	2K48	5FP7A	10KP7	714A	711A	931A	6680	6007
6G1A4C	1P39	2K50	5FP14A	10KP17	715A	714A, AY	CW-931A	6684	6008
/1B67	1P40	2K54	5GP1	A-11	MIL-322	715A, B, C	954	6686	6011
1AB4	1P42	2K55	5HP4	12AT7	721A	715C	955	6687	6021
8S-1	1Z2	2K56	5J21	WA	C-316	715A	955	6687WA	6028
CIS/	2AE/15	2K2A	5J26	12AU7	717A	720	957	6697WA	6029
1CS1	2AS/15	2K2B	5J27	WA	719A	SERIES	958A	6698	6045
1D22	2A21	3B4	5J30	15E	724A	723A	959	6702	6050
1D25	2AP1	3B24	5J32	FG17	1A5A	CK-722A	991	6697	6060
1D26	2BP11	3B24W	5JP1	HK24	1B3A, B	CK-722	992	6706	6074
1D34A	2B22	WA	5LP7	HK24	1S4C, F	721A/B	CK1005	6707WA	6076
1D37	2C4	3B25	5NP1	24G	1S5A	724B	CK1006	6708	6087
1D38	2C22	3B26	5R4GY	45Z5GA	1S5A, B	724A	CV1012K	6708WA	6087
1D38A	2C24	3B28	5R4WGY	RK20	ML381	724A, B, C	VC-1256	6761WA	6088
1D38	2C35	3B29	5RP11A	25T	1B5A	724C	QG-1/295	6762	6089
1D37A	2C36	3B32	5V3W	25Z6W	1B5A	SERIES	QG-2/501	6716	6097
1D38	2C39, A	3C23	GTA	GT	1B6A	724TL	1603	6719	6109
1D40	2C40	3C31	5ZP16	26Z6W	1B7A	800	1611	6722	6109
1D42	2C41	3C45	6AC7W	30W	1B7A	801A	1612	6723	6109
1D44	2C43	3D6	6AC7WA	31Z	1B8A, B	802	1614	6726	6111
1D46	2C44	3D21A	6AF4A	RK-34	1B8A	803	1616	6727	6112
1D47	2C48	3D22	6AG7Y	31T, TG	RK20A	804	1620	6727	6116
1D50	2C50	3D24	6AH4	RK-39	1B8A	805	1626	6732	6140
1D51	2C51	3DP1, S2	6AH6	T-40	1B8A	808	1628	6733	6141
1D52	2C52	3E29	6AJ6/	TZ-40	1B8A, W	809	1634	6744	6142
1D53	2C53	3EP1	1A2D	RK-47	1C5A	810	1635	6749	6147
1D54	2D21	3FP7A	6AK5W	RK-49	1C5A, B	811	1636	6750	6148
1D57	2D21W	3GP1A	6AL5W	V-50	1C21A/5842	812	1638	6751	6149
1D58	2E22	3J31	6AN5, WA	52HAP7	1C21A	813, A	1639	6761	6149
1D59	2E24	3K21	6AN6	RK-65	1C21A	813, A	1632	6762	6149
1D60	2E26A	3K23	6AQ5W	HY-65	1C21A	833	1633	6765	6159
1D61A	2E26	3K23	6AR6	HY-69	1C21A	833	1633	6766	6159
1D98	2E30	3L54	6AS6W	RK-72	1C21A	833	1633WA	6768	6159
1D100	2E35	3QA-4	6AS7G	RK-73	1C21A	834	1641	6786	6206
1C	2E32	5N-4	6BA6W	RK-75	1C21A	836	1642	6787	6214
1C21	2E36	4-65A	6BA7	35T, TL	1C21A	836	1643	6788	6215
1D	2E36	4-125A	6BE6W	35Z5GT	1C21A	836	1644	6795	6247
C1K	2G21	4-250A	6BF5	CV-92	1C21A	836B	1754	6796	6249
1N21,	2N21	4-400A	6BF7, W	C-300A	1C21A	836B	1756A	6797	6249
B, C, Zm		4-1,000A	6BJ6	HF100	1C21A, B	836B	1907	6798	6250
1N22	2J22	4B22	6BM6	100TH,	ZP-440	837	1914	6799	6249
1N23, A,	2J23	4B23	6BM6A	TL	450TH,TL	838	2050	6800	6249
B, C, Zm	2J24	4B24	6C	181D	810A	841	2051	6802	6250
1N25	2J26	4B25	6C4W	FG105	4E40	857	4210	6814	6251
1N26	2J26	4B26	6C21	F-324A	4E41A	858	4211	6814A	6252
1N27	2J27	4B27	6D4	FG154	4E42	860	4260	6815	6012, A
1N31	2J29	4B28	6F4	WE123A	5B1A	863	4260	6820	6012, A
1N32	2J30	4B31	6H6WGT	VT127, A	5D6AX	864	4261	6821	6012AA
1N32, A	2J31	4B32	6J5	6AN	5E4W	865	5550	6830	6016
1N36	2J32	4B36	6J5	152TH	5D6	866	5557	6838	6021
1N38A	2J33	4C22	6J6	NR158	5D6	866A	5637	6839	6021A
1N39	2J34	4C27	6J6WA	10	5E4X	866B	5638	6840	6022
1N41	2J36	4C28	6J6WGT	RK282	5E4AX	866C	5639	6841	6023
1N42	2J38	4C35	6J6WA	201A	5J4AX	866D	5640	6842	6024
1N43	2J39	4C36	6LGWGA,	203A	5J4AX	866E	5641	6843	6025
1N44	2J42	4D21	GB	207	5J5AX	866F	5642	6844	6026
1N47	2J48	4D32	C6W	211D	5J6	869A	5643	6845	6027
1N48	2J49	4E27	6SA7W	211D	N-531	869B	5644	6846	AX3993
1N55	2J50	4J31	GT	211E	526A	870	5645	6853	B5111A
1N56A	2J51	4J34	6SA7Y	211F	527A	871A	5646	6854	D164476
1N57	2J52	4J34	6SB7Y	250B, C	531AX	872	5647	6870	D164505
1N60	2J54	4J42	6SC7GTY	RK210A	531AXA	872A	5648	6881	D176461
1N61	2J55	4J43	6SG7Y	250A, B, C	531AX	872A	5649	6891	159650
1N65	2J56	4J51	6SJ7Y		571AX	874	6641	6894	161160GS1

PRICES AND CATALOGUES ON REQUEST.

SEND US YOUR INQUIRIES.
WE BUY ALL TYPES ELECTRONIC TUBES. TOP PRICES PAID.
PHONE NOW! SAME DAY SHIPMENT!

FOR SALE
4,000 5814 Original Cartons JAN
1,000 5702WA Certified JAN
100 4X150A Original Cartons COMM
1,000 9002 Original Cartons JAN

V & H RADIO AND ELECTRONICS SUPPLY
2079-2042 W. VENICE BLVD. LOS ANGELES 6, CALIF. REpublic 9

A.B. RESISTORS

Phone: Yonkers 9-6000
Legri S Company
391 Riverside Ave.
Yonkers 5, N. Y.

SPECIAL PURPOSE TUBES

OA2 .70	3J31 35.00	RK-49 2.85	CK-510AX .50	SN-976D 8.50
OA4G 1.00	3K27 125.00	FP-54 35.00	GL-546 2.00	991/NE-16 .30
OA5 4.00	3KP1 5.00	HK-54 2.00	559 .45	CK-1005 .30
OB2 .70	3X2500A3 100.00	T-55 3.50	575A 7.50	CK-1006 2.50
OB3/VR-90 .75	4-400A 40.00	RK-60/1641 1.35	631-P1 6.00	SN-1006 6.50
OC3/VR-105 .70	4B22 6.50	RK-61 3.00	WL-632A 17.50	CK-1007 .60
OD3/VR-150 .65	4B23 5.00	HY-65 1.35	WL-652/57 40.00	SN-1007A 6.50
EL-CIB/3C31 1.50	4B27 2.25	RK-65/5D23 7.50	WL-655/58 100.00	SN-1007B 8.50
1AD4 1.15	4B31 20.00	FG-67 9.00	WL-681/86 25.00	CK-1009/BA 3.00
1AF4 2.50	4C27 5.00	HY-69 2.75	WE-701A 2.50	SC-1016C 6.50
1AG5 2.00	4C35 17.50	RK-72 .50	703A 1.25	SC-1017C 6.50
1B22 1.50	4E27/8001 8.00	RK-73 .50	WE-704A .70	CK-1026 2.90
1B24 5.00	4J34 30.00	RK-75/307A .85	WE-705A .70	SN-1039A 6.50
1B35 4.50	4J52 50.00	75TL 7.50	706AY-GY 12.50	SC-1136A 6.50
1B38 25.00	4X100A 15.00	FG-81A 3.50	707B 3.50	1500T 125.00
1B47 5.00	EL-5CB/5C30 1.00	FG-95 17.50	WE-714A 10.00	1603 3.50
1P21 25.00	5AP1 2.50	100R 5.00	WE-714AY 20.00	1614 1.50
1P28 8.50	5B21 1.00	100TH 5.50	715B 3.50	1619 .30
1P29 & 30 1.50	5BP1 2.00	WE-122A 1.50	715C 11.50	1624 1.25
1P36 & 37 2.25	5BP1A 5.00	F-123A 5.00	717A .35	1625 .30
2AP1 4.00	5BP2A 4.75	WE-123A 2.50	WE-719A 12.50	1846 50.00
2AP1A 6.00	5BP4 2.00	VT-127A 2.00	720AY-EY 35.00	2050 1.00
2AS15 3.75	5C22 25.00	F-128A 15.00	721A .75	ZB-3200 100.00
2C38 7.50	5CP1 2.00	F-129B 150.00	721B 7.00	R-4330 7.50
2C39 5.00	5CP1A 8.50	VXR-130 1.65	723A/B 8.50	5528 5.00
2C39A 12.50	5CP7 8.50	HK-154 5.00	WE-724B 1.00	5550 25.00
2C40 10.00	5CP7A 13.50	FG-166 14.00	WE-725A 5.00	5551 40.00
2C42 10.00	5CP12 10.00	FG-172 25.00	WE-726A 5.00	5553 100.00
2C43 10.00	5D21 7.50	QK-181 20.00	WE-726B 25.00	5556/PJ-8 6.75
2C44 .45	5FP7 1.50	FG-190 7.50	WE-726C 20.00	5557 3.75
2C46 6.00	5FP14 7.50	HF-200 8.50	WE-730A 7.00	5558 5.00
WE-2C51 2.90	5GP1 5.00	CE-203 3.50	750TL 40.00	5560 17.50
2C53 10.00	5HP1 2.00	203A 2.50	WL-759 12.50	5610 1.00
2D21 .75	5J29 7.50	207 35.00	SA-782B 2.00	5632 8.50
2D21W 1.35	5J30 5.00	WE-211C 10.00	WL-786 14.00	5634 6.50
2D29 2.00	5J32 10.00	WE-211D 8.00	801A .50	5637 3.75
2E22 3.00	5JP1 12.50	WL-218 15.00	809 2.00	5638 6.50
2E24 1.95	5JP2 6.25	232CH 100.00	803 2.00	5640 8.50
2E26 3.00	5JP4 6.25	CE-235A 5.00	804 8.50	5642 1.00
2E29 1.00	5JP5A 6.25	WE-242C 7.00	805 5.00	5644 6.50
2E36 1.25	5JP11 9.00	WE-244A 7.50	807 1.10	5645 8.50
2J21A 2.75	5LP1 7.50	WE-245A 7.50	807W 2.00	5650 85.00
2J26 & 27 4.00	5LP1A 20.00	WE-249B 2.50	808 1.00	5651 1.35
2J29 15.00	5NP1 2.00	WE-249C 2.50	809 2.75	5654 1.20
2J30 35.00	5R4GY .85	250R 3.75	810 10.00	5656 6.50
2J31 12.50	5R4WGY 2.50	250TH 17.50	811 2.90	5670 1.45
2J32 10.00	5X3 3.00	250TL 14.50	811A 3.50	5672 1.15
2J33 17.50	5X3P1 75.00	WE-251A 45.00	812 2.90	5676 1.25
2J34 & 36 12.50	5Z3P7 50.00	WE-259A 9.50	813 (RCA) 12.00	5678 1.00
2J37 4.00	5Z4P11 100.00	WE-263A 2.50	814 1.50	5687 2.00
2J38 10.00	EL-C6J 6.25	WE-264A 3.50	815 1.00	5691 4.25
2J39 7.50	EL-C6L 5.00	WE-267A 3.00	816 1.00	5692 4.25
2J40 15.00	EL-6C/4B25 8.00	FG-258A 100.00	826 .50	5693 3.50
2J51 125.00	6AC7W 1.00	WE-262B 5.00	SD-828A 6.50	5696 1.00
2J52 50.00	WE-6AK5 1.10	267B 5.00	SD-829E 6.50	5703 1.00
2J54 35.00	6AK5W 1.20	WE-268A 7.50	828 9.50	5720 15.00
2J55 50.00	6AL5W .55	FG-271 40.00	829 5.50	5725 1.50
2J56 75.00	6AN5 2.75	WE-274B .90	829B 8.50	5726 .55
2J61 15.00	6AR6 1.25	WE-276A 7.50	830B .50	5727 1.35
2J62 7.50	6AS6 1.25	WE-282A 6.00	832 3.00	5728 9.00
2K22 15.00	6AS6W 1.50	WE-283A 3.50	832A 5.00	5734 9.00
2K25 11.50	6AS7G 2.50	WE-285A 5.00	833A 35.00	5740 35.00
2K30 100.00	6C21 17.50	WE-286A 6.00	SD-834 3.75	5750 2.50
2K33A 50.00	6J4 2.00	287A 2.50	834 7.50	5763 1.35
2K34 85.00	6J4WA 3.50	HF-300 25.00	836 1.50	5800 7.50
2K39 125.00	6J6W 1.50	WE-300B 5.00	837 1.10	5801 5.00
2K41 85.00	6L6WGB 2.50	304TH 7.50	838 1.00	5803 7.50
2K47 125.00	6SK7W 1.50	304TL 12.50	842 1.85	5819 30.00
2K54 7.50	6SN7W 1.50	WE-305A 2.85	845 4.00	5827 5.00
2K55 5.00	6SU7GTY 2.00	307A .85	845W 7.50	CK-5829 1.50
2P21 (I. O.) 25.00	6X5W 1.25	WE-310A 4.00	849 20.00	5842 12.50
2V3G 1.25	7BP7 3.50	WE-313C 3.00	851 9.00	5847 12.50
2X2A .90	7CP1 10.00	316A .50	860 2.75	5915 1.00
3A4 .50	7EP4 10.00	WE-323A 7.50	866A 1.20	5932 4.00
3A5 .50	12AP7 50.00	323B 4.00	866 JR 1.00	5933 2.00
3AP1 2.00	12DP7 17.50	WE-328A 3.50	869B 35.00	5948/1754 200.00
3AP11A 5.00	12GP7 17.50	WE-337A 7.50	872A 1.25	5962/BS-101 6.50
3B21 3.50	LM-15 (I.O.) 50.00	WE-339A 7.50	884 .95	5963 1.40
WE-3B24 1.00	FG-17 3.75	WE-347A 3.00	885 .95	5979/BS-1 15.00
3B24W 4.75	RK-20A 7.50	WE-350A 2.65	902A/P1 2.00	5980/BS-2 10.00
3B25 3.00	TZ-20 1.50	WE-350B 2.65	913 20.00	5981/5650 85.00
3B26 2.85	RK-23 2.50	WE-352A 15.00	917 2.00	5998 7.00
3B27 3.00	HK-24 3.00	WE-355A 12.00	918 1.50	6328 12.50
3B28 4.85	HK-24G 2.00	WE-356B 5.00	922 2.00	8002R 15.00
3BP1 2.00	CE-25A/B 1.00	WE-368A/AS 2.00	923 1.40	8005 4.75
EL-3C/4B24 5.00	RK-25 2.25	371B 1.50	927 .95	8012 1.00
EL-3CJ 8.50	25E6WG 4.00	WE-388A 1.50	931A 2.50	8012A 3.50
3C23 4.50	25T 3.00	WE-393A 4.50	SN-947C 6.50	8013 2.50
3C24 2.50	25TG 2.50	394A 1.85	SN-947D 8.50	8013A 3.50
3C33 7.50	FG-27A 13.00	WE-396A 2.90	SN-948B 6.50	8020 1.50
3C45 5.85	28D7W 1.50	WE-403A 1.10	SN-948D 6.50	8025 1.25
3D22 9.75	FG-32 5.00	WE-404A 12.50	954 .30	8025A 2.00
3DP1 3.00	VX-32B 7.50	GL-415 25.00	955 .35	PD-8365 50.00
3DP1A 7.50	FG-33 15.00	WE-417A 12.50	SN-956B 1.00	9001 .85
3E29 8.50	VX-33A 5.00	WL-417 2.50	956 .35	9002 .60
3EP1 2.00	35T 3.00	WE-418A 15.00	957 .35	9003 1.25
3FP7 2.00	35TG 2.50	WE-421A 7.00	958A .35	9004 .35
3FP7A 2.50	VX-41 5.00	GL-434A 10.00	959 1.35	9005 1.40
3GP1 2.00		446A .40	SN-974B 8.50	9006 .25
3HP7 3.00		446B 1.50		9903 20.00
3J21 50.00		464A 2.15		

western engineers

ELK GROVE, CALIFORNIA

GEORGE WHITING OWNER

Prices are F O B shipping point

Orders for less than ten dollars cannot be processed

All tubes are neap individually cartoned, fully guaranteed

Bargains in Brand New Surplus

★ *Starred Items Available in Production Quantities at Special Prices*

These are only a few of our specials; write us your requirements

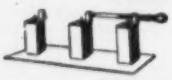
OIL FILLED CAPACITORS

VOLTS	MFD	Price	VOLTS	MFD	Price
25KV	1.0	*49.95	1000	28.0	5.50
25KV	0.5	*39.95	1000	2.0	.49
25KV	0.1	14.95	1000	0.5	.19
7.5KV	0.5	4.25	600	10	1.29
6KV	0.25	1.09	600	8	1.19
3KV	0.5	1.59	600	4	*.69
3KV	0.1	*1.19	600	2	*.39
2.5KV	2.0	*2.95	600	1	*.19
2KV	5.0	2.95	660AC	5	2.99
2KV	.25	.89	330AC	5	1.25

PULSE NETWORK SPECIAL

Sprague 15-1-400-50 15 Kv 1.0 usec 400 P.P.S. 50 ohm Z ★$2.95

SWITCHES



Square D Antenna change switch Bakelite base 2x8x1¼ ★49¢

Mu Switch	RC-1P	norm. closed	.59
Mu Switch	RO-1P	norm. open	.59
Mu Switch	RD-1P	double-throw	.69
Micro Switch	WZ-RQ1	norm. closed	.69
Micro Switch	YZ-RQ1	norm. open	.79
Micro Switch	WZ-RL8	norm. closed	.49
Micro Switch	BZ-R	double-throw	.45
Micro Switch	G-R32	norm. open	.34
ST 50 R DPDT	on-momen. on		.89
ST 48 G SPDT	momen.-off-momen.		.44

MULTIPLE SECTION OIL CAPACITORS

10 mfd 400V meets 600V specs; Dual 5mfd 3 term. 3½ Hx 3½ W x 2D ★59¢

9½ mfd 600V meets 1000V specs; 8 sect. 2-2-2-1-1-½-½-½ 4¾ H x 4½ W x 1½ D ★59¢

TRANSMITTING CAPACITORS

10KV	0002	5.95	3KV	0065	*.99
10KV	00015	*5.95	3KV	00025	.99
10KV	00024	4.95	3KV	0002	.99
2KV	03	10.95	2KV	02	1.29
1KV	04	4.95	2KV	015	1.29
			2KV	00015	.99
			1KV	.1	1.39
			600V	.4	1.39

2500WV	008	.89			
1200WV	01	.59			
1200WV	0051	.49	2500WV	005	.89
600WV	01	*.32	2500WV	0036	*.69
600WV	02	*.45	2500WV	001	.44
600WV	001	.19	2500WV	0001	.29

VARIABLE TRANSMITTING CAPACITORS

19 to 115mmfd 27 plates, .035" air gap. O/a dim. 4¾L x3½x2¼ SC# 3D 9819 V ★98¢

3 PHASE INDUCTION VOLTAGE REGULATOR

General Electric Type 1RT. 1.64 Kva. Filled with 9 gal. oil. Primary 208 volts. Brand New. Limited Quantity. Special $90.00

POWER RHEOSTATS

Types H, J and I

ohms	watts	bush.	shaft	each
1	150(H)	3/8	7/16	2.68
8000	50(J)	3/8	9/16	*.79
3	25(H)	3/8	1/8 sl.	.79
8	25(H)	3/8	1"	.79
100	25(H)	3/8	7/16	.79
150	25(H)	3/8	7/16	.79

POTENTIOMETERS

2 Watts Types JU and JLU

ohms	type	bush.	shaft	each
50	JU	1/2	1/2	.54
1000	JU	1/4	3/16sl.	*.49
5000K	JU	1/4	1/2	.59
2000	JLU	lock	3/16sl.	*.44
2000	JLU	lock	3/16sl.	.54
10000	JLU	lock	3/16sl.	.59

RELAYS

Amperite 6NO-110 time delay relay, octal tube base 6V Heater, normally open. Contacts rated 3A. ★99¢

Allied BO 13D35 SPST Double break normally open 24V DC. Coil Silver contacts each rated 15 Amp @ 24V DC or 115V AC ★98¢

Autelco Jr Type 16 115V AC coil DPDT Snap Action contacts rated 15 Amp 115V, 5 Amp 230V 2.95

Cook #773 Standard Telephone Relay 900 ohm DC coil double arm 14 contacts 11A-1B-1C-1D 4"Lx1½"W x2½H ★1.09

COAXIAL CABLE & CONNECTORS

RG 9 B/U ★15.00 C FT

PL 259 Plug ★29¢

Amphenol 83-1AP Angle Adaptor ★18¢

ALL PRICES F.O.B. OUR WAREHOUSE

TERMS: Net 10 days to firms rated well in D.B. Others deposit or cash with order balance C.O.D. Please include postage.

RUXUR ELECTRONICS CORP.

623 Hudson St., New York 14 WA 4-7260

SEARCHLIGHT SECTION

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

10 CM.—RG48/U Waveguide

POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" connectors $12.50

LHTR. LIGHTHOUSE ASSEMBLY. Parts of RT39 APG 5 & APG 15. Receiver and Trans. Cavities w/ assoc. Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated $15.00

BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each $27.50

MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated $31.50

721A TR BOX complete with tube and tuning plunger $12.50

McNALLY KLYSTRON CAVITIES for 707B or 2K28, 2700-2900 MC $4.00

HOLMDELL-TO-TYPE "N" Male Adapters. W. E. #D167284 ..... $2.75

BEACON ANTENNA AS31/APN-7 in Lucite Ball. Type "N" feed $22.50

ANTENNA, AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed $12.50

"E" PLANE BENDS, 90 deg. less flanges $7.50

K-Band, X-Band Eqpt. Available ..... Send for List

APS-2 SPARE PLUMBING

Z-601C: Elevation Joint $9.50

Z-601B: Transmission Line from El. Jt. to antenna feed $4.50

Z-501A: Antenna and Dipole feed assy. $12.50

Z-601E: Azimuth Rotating Joint $15.00

Z-914: Long Rt. Angle Bend, 90 Deg. $4.50

Z-910: Short Rt. Angle Bend with pressure fitting $3.50

X BAND—1" x ½" WAVEGUIDE

AT-48/UP 3 CM Horn with type N. feed for receiver measurements, etc. New (as shown) $7.45

PARABALOID DISH, 18" diam. Spun Aluminum, 8" Focus. For AN/APS-6 ..... $4.95

3 CM. DIPOLE and Feed Assembly. (May be used with above dish.) 8 inches long $5.00

FLEXIBLE SECTION 9 in. long. Cover-to-Cover $5.50

ROTARY JOINT (APS-6) Sperry PT #658275, 180 deg. rotation, choke to choke. Has "Built-in" DI-Coupler 20 DB, with "N" Takeoff $22.50

3CM. DIPOLE FEED, 15" L. for APS-15 ..... $14.50

MITRED ELBOW, Cast aluminum, 1¼" x ⅝" W.G. W.E. Flanges. "E" Plane $3.50

3 CM ANTENNA ASSEMBLY: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan: over 160 deg. at 25 scans per minute. Elevation Scan: over 2 deg. Tilt. Over 24 deg. $35.00

Cross-Guide Directional Coupler. UG-40 output flange. Main Guide is 6" Long, with 90 Deg. "E" Plane bend at one end, and is fitted with Std. UG 39/UG 40 flange. Coupling figure: 20 db Nominal $22.50

RG52/U Waveguide in 5' lengths, fitted with UG 39 flanges to UG40. Silver plated. ..... per length $5.00

Rotating-Joints supplied either with or without deck mountings. With UG40 flanges ..... each $17.50

Bulkhead Feed-thru Assembly $15.00

Pressure Gauge Section with 15 lb. gauge $10.00

Directional Coupler, UG-40/U Take off 20db $17.50

MAGNET AND STABILIZER CAVITY For 2J61 Magnetron $24.50

90 degree elbows, "E" or "H" Plane 2½" radius. $8.50

ADAPTER, waveguide to type "N", UG 81-U, p/o TR 12, TR 13, Etc. $7.50

ADAPTER, UG-166/U round cover to special BPT. Flange for TR-45, etc. ..... $2.50 ea.

APS-1S SPARE PARTS

CU-73/APS-15A, SCR #223265-73 right angle bend, E plane, 6¼" x 10", with directional coupler on 6¼" arm, type "N" takeoff 20 db coupling. ..... $12.50 each

Z-607 Dwg. Symbol. Approx. 150 degree bend with 90 deg. twist. One end pick-up loop with press. fitting $6.50

Z-614: Philco 756-1142, CG124/APS-15A. Wave-selector: approx. 16" L with 15 deg. bend at center (E-plane) 20 db coupling $12.50

Philco 348-1425, 180 deg. bend, with pressure fitting $4.50

Z-609, Philco 348-4629, 13⅛" run, with bend & 90 deg. twist (on 3¼" section) $6.75

Z-606: 8" run with 30 deg. bend (E-plane) one end $4.50

Philco 348-1427 E plane bend 11" x 6⅛" $6.50

CG1/APS-3 Philco 358-5212, S-curve 16" L with round contact flanges $9.75

WAVEGUIDE FLANGES

UG 39/U	$1.20	UG 51/U	$1.65
UG 40/U	$1.35	UG 52/U	$3.40
UG 40A/U	$2.00	UG 52A/U	$3.40

"K-BAND" WAVEGUIDE

Right Angle Bend E or H Plane, specify combination of couplings desired $12.00

Mitred Elbow cover to cover $4.00

TR-ATR-Section Choke to cover $4.00

Flexible Section 1" choke to choke $5.00

"S" Curve Choke to cover $4.50

THERMISTORS

D-164699 Bead Type DCR: 1525-2550 Ohms @ 75 Deg. F. Coefficient: 2% Per Deg. Fahr. Max. Current 25 MA AC/DC $1.00

D-167332 Bead Type, DCR is 1525-2550 Ohms. Rated 25 MA at .825-1.175 VDC $1.00

D-167613 Disk Type DCR: 355 Ohms @ 75 Deg. F.P.M. 2.5%, 1 Watt $1.00

D-166228 Disk Type 7/20 Ohms @ 60°F, 4220 Ohms @ 80°F 2590 Ohms @ 100°F, 1640 Ohms @ 120°F $1.00

POWER TRANSFORMERS

COMBINATION—115V/60~INPUT

CT-518	**160-0-160V/70MA, 6.3V/2A, 2.5V/1.75A**	**$2.15**
CT-575	**1600V/2MA., 6.3V/.6A, 2.5V/1.75A**	**4.95**
CT-127	**900V/250MA PK. 5V/2A, 7V/7.5A**	**2.79**
CT-096	**350-0-350V/120MA, 5VCT/1A, 2.5VCT/12.5A, 2.5VCT/3.5A**	**4.39**
CT-965	**7½V/6.6A, 6.3V/2A**	**1.95**
CT-994	**350-0-350V/90MA, 5VCT/3A, 2.5VCT/12.5A**	**4.60**
CT-982	**350-0350V/80MA, 5VCT/2A, 2.5VCT/7.5A**	**3.65**
CT-479	**7000V/.018V, 2.5V 5A/17,000 V. Test**	**22.50**
CT-483	**350VCT .026A 5V/3A**	**2.75**
CT-931	**585VCT .086A 5V/3A, 6.3V/6A**	**4.25**

PLATE—115V/60~INPUT

PT-97	**400VCT/4.0 AMPS For RA43**	**17.50**
PT-834	**125V45MA (For Preamp)**	**1.15**
PT-133	**3140/1570V. 2.36KVA**	**85.00**
PT-521	**7500V/.06A. Half Wave**	**$8.50**
PT-913	**2500V/12 MA H'SLD**	**4.95**
PT-38-2	**17.5-40V AT 750 MA**	**2.15**
PT-67P	**860VCT/230MA DC**	**4.75**
PT-876	**1500-0-1500V./400MA**	**12.50**
PT-151	**2060VCT/6.175A**	**18.50**

FILAMENT—115V/60~INPUT

FT-157	**4V/16A, 2.5V/2.75A**	**2.95**
FT-181	**6V/.25A**	**.75**
FT-824	**5.25A/21A, 2x7.75V/6.5A**	**14.95**
FT-824	**2x26V/2.5A, 18V/1A, 1.2V/7A, 6.4V/18A, 6.4V/2A**	**8.95**
FT-483	**6.3VCT/1A, 5VCT/1A, 5VCT/3A**	**3.49**
FT-85-2	**7.2V/21.5A; 6.5V/6.85A, 5V/6A, 5V/3A**	**8.95**
FT-38A	**6.3V/2.5A, 2x2.5V/7A 5KV Test**	**2.79**
FT-650	**2.5V/10A-3KV TEST LO-CAP**	**7.50**
FT-625	**2.5VCT/10A, 10KV TEST**	**6.95**
FT-650	**2.5V/40A, 3KV TEST**	**7.50**

FILTER CHOKES

Stock	Description	Price
CH-514	**12HY/250 MA 2500 V. Test**	**$3.25**
CH-CEC	**117: 9-60H/.06-.400 MA, 10 KV Test**	**14.95**
CH-113	**2.5H/700 MA, 2.5 KV Test 18 Ohms**	**5.75**
CG-644	**8.5H/350 MA, 2.5 KV Test 50 Ohms**	**3.25**
CH-291	**O-1H/12 A. DCR: 0.3 Ohms**	**12.50**
CH-322	**.35H/350 MA—10 Ohms DCR**	**2.75**
CH-141	**Dual 7H/75 MA, 11H/60 MA**	**4.69**
CH-69-1	**Dual 120H/17 MA**	**2.35**
CH-778	**1.2H/130 MA/75 ohms**	**2.25**
CH-344	**1.5H/145MA/1200V Test**	**2.35**
CH-366	**20H/100 MA.**	**6.95**
CH-999	**15HY/15 MA—400 ohms DCR**	**1.95**
CH-445	**0.5HY/200 MA, 32.2 ohms, 3000 V.T.**	**1.39**
CH-178	**2x0.5H/350 MA, 25 ohms.**	**2.75**
CH-124	**5H/200 MA, 3KV Test**	**3.25**
CH-181	**12H/300 MA, 1KV Test**	**4.65**
CH-88C	**Swing 5-20H/0-300 MADC**	**5.25**

400 CYCLE TRANSFORMERS

(All Primaries 115V 400-1200 Cycles)

KS13101	**6.3V/15A, 6.3V/8.9A, 6.3V/8.4A, 6.3V/9.2A**	**$3.85**
KS13104	**1450VCT/0.283A, 1050VCT/0.217A**	**7.50**
KS9318	**6.3V/4A, P/O R-55/ARQ-9**	**1.35**
KS9408	**1233/.35MA, 1146VCT/.07A**	**5.79**
152-7182	**6.3V/2.5A**	**1.45**
M-7472426	**1450V/1.8MA, 2.5V/.75A, 6.4VI/3.9A, 5V/2A, 6.5V/.3A, P/O ID-39/APG-13**	**4.95**
352-7839	**640VCT @ 310MA, 6.3V/.9A, 6.3V6A 5V/6A**	**5.49**
706724	**9800, 8600 @ 32MA**	**8.95**
KS9584	**5000V/200MA, 5V/10A**	**22.50**
KS9467	**734VCT/.177A, 1718VCT/.177A**	**6.75**
352-7273	**700 VCT/350MA, 6.3V/8.9A, 6.3V/25A, 6.3V/.08A, 5V/CA**	**6.95**
352-7878	**2x2.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/100, 750V, & .095A**	**7.45**
352-7136	**1140/1.25MA, 2.5V/1.75A, 2.5V/1.75A—5KV TEST**	**3.95**
352-7176	**320VCT/50MA, 4.5V/3A, 6.4V/CT 2A, 2x6.3VCT/6A**	**4.75**
RA6400-1	**2.5/1.75A, 6.3V/2A—5KV Test**	**2.39**
901692	**13V/9A**	**2.49**
901699-501	**2.77V/.6A, 4.2A—10KV Test**	**3.45**
901698-501	**900V/75MA, 100V/.04A**	**4.29**
Ux8855C	**900VCT/.067A, 5V/3A**	**3.79**
RA6405-1	**800VCT/95MA, 5VCT/1A**	**3.69**
T-48852	**700 VCT/206MA, 5V/3A, 6V/1.75A**	**4.25**
352-7088	**2500V/6MA, 300VCT/115MA**	**5.95**
M-7474319	**6.3V/2.7A, 6.3V/.66A, 6.3VCT/21A**	**4.25**
KS8194	**27V/6.1A, 6.3V/2.9A, 1.25V/.02A**	**2.95**
52C089	**650VCT/50MA, 6.3VCT/2A, 5VCT/2A**	**3.75**
32332	**400 VCT/15MA, 6.4V/2.5A, 6.4V/15A**	**3.85**
69G631	**1150-0-1150V 2MA**	**2.75**
80G198	**6VCT/.08095 KVA**	**1.75**
382433A	**6.3V/9.1A, 6.3VCT/6.5A, 2.5V/1.5A, 2.5/3.5A**	**4.85**
KS 9445	**592VCT/18MA, 6.3V/8.1A, 5V/2A**	**5.39**
KS9685	**6.4/7.5A, 6.4V/1.8A, 6.4/2.5A**	**4.79**
70G136G1	**600VCT/16MA**	**2.65**
M-7474318	**2100V/.027A**	**4.95**
352-7069	**2-2.5V Wdgs at 2.5A, Each Lo-Cap., 22Kv Test**	**5.95**
352-7096	**2.5V/1.79A, 5V/13A, 6.5V/6A, 6.5V/1.2A, D/O BC800**	**4.95**

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	PRICE
BDAR83	**14**	**...**	**375**	**.150**	**$6.50**
15X-600	**12**	**3.8**	**600**	**.095**	**4.35**
DM33A	**28**	**7**	**540**	**.250**	**3.95**
B-19	**12**	**9.4**	**275**	**.133**	**6.95**
DA-3A*	**28**	**19**	**500**	**.050**	**3.95**
			300	**2.6**	
			150	**.010**	
			9	**14.5**	
PE 73 CM	**28**	**19**	**1000**	**.150**	**17.50**
BD 69	**14**	**2.8**	**220**	**.08**	**8.95**
DAG-33A	**14**	**3.2**	**450**	**.06**	**2.50**
BDAR 93	**28**	**3.25**	**375**	**.150**	**5.75**

‡ Less Filter.

* Replacement for PE 94.

† Used, Excellent.

PE 94., Brand New 5.95

Navy type CAJO-211444. Input: 105 to 130 VDC. Output: either 26 VDC at 20 amps. or 13 VDC at 40 amps. Radio filtered and complete with line switch. New $69.50

INVERTERS

800-1B input 24 vdc, 62 A. Output: 115 V, 800 cy. 7A, 1 phase. Used, excellent $18.75

PE-218H: Input: 28/36 vdc, 92 amp. Output 115V 800/500 cy. 1000 Volt-ampere. NEW $32.50

PE206: Input: 28 vdc, 36 amps. Output: 80 V 800 cy, 500 volt-amp. Dim. 13 x 5½ x 10½. Now $22.50

EICOR—ML 3011-3. Input: 13.75 V; 18.4A. Output: 115 V/400—, 3ϕ, 0.98 PF, 100 VA. New $50

PU 7/AP. Input: 28 vdc/160A. Output: 115 VAC, 400—, 1ϕ, 900 VA., 21.8 Amp Volt. and Freq. Reg. Used, Exc. $75

D.C. RELAYS*

CR2792B116A3

SPST—50 Amp Contacts. Operates from 22-30 VDC. Coil Res. 200 Ohms. Completely enclosed in transparent plastic case, which may be removed for adjustments $1.10

GE #CR2791B116W3

Same as above, except additional terminal brought out from contact arm $1.30

GE #CR2791-F100D3

Differential: DPST, Norm. open. Dual coil, 1500 ohms per coil — 25 Ma. Operating Current. Contact: 20 Amp. $1.85

GE #CR2791F100G3

Same as above, except has extra 1A contact. Rated 5 Amp. $1.95

GE #CR2791-D101F3

All Ceramic Insulation, DPDT, Coil — 12VDC, 100 Ohms DCR. Contacts designed for fast operation. Rated at 5 Amps. $1.00

GE #CR2791B106J3

SPDT, 5 Amp contacts. Coil rated 22-30VDC. 150 Ohms DCR. Contacts are designed for fast operation, and enclosed by clear plastic cover $1.10

GE #CR2791B106C3

SPDT, Dual Contacts will handle 20 Amps. Coil: 18-28 VDC 125 Ohms DCR $1.25

***THESE RELAYS AVAILABLE IN MFRS. QUANTITIES**

PULSE TRANSFORMERS

4P37: Primary, 50 Ohms 750V. .001 Duty. Sec. 15KV. 1000 Ohms Impedance Bifilar 12.6V/2.5A $32.50

RAYTHEON WX 4298E: Primary 4KV., 1.0 URES. SEC. 16KV-16 AMP DUTY RATIO: 001 400 CYCLE PIL. TRANS. "BUILT-IN" $22.50

WECO: D-163247 For Modulator of SCR 720 ..... $22.50

GE #K-2449A
Primary: 9.23 KV, 50 ohms Imp.
Secondary: 28 KV, 450 ohms.
Pulse length: 1.05/5 usec @ 635/120 PPS. PK Power Out: 1,740 KW.
Bifilar: 1.5 amps (as shown) $62.50

GE #K-2748-A, 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.5 Amp. Fitted with magnetron well $24.50

K-2745 Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar, 1.3 Amp. Has "built-in" magnetron well $32.50

K-2461-A, Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar 1.3 Amp. Fitted with magnetron well $29.50

541318-1—3 wdgs. Ratio: 1:1:1, 1.10 uh. /wdg., 2.5 ohms DCR $3.50

UTAH X-151T-1: Dual Transformer, 3 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 50 ohms DCR $5.00

UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg. $5.00

K-904695-501: Ratio 1:1, Pri. Imp. 40 Ohm. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.65 usec rise $8.95

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P.O. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK OR RAILEX.

343 Canal St., New York 13, N.Y. Dept. E-4 Chas. Rosen Phone: CAnal 6-4882

NEW YORK'S RADIO TUBE EXCHANGE

NEW TUBES

Standard brands. First grade only. No pull outs. No rejects. No rebrands. At lowest prices.

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
OA2	$1.60	2T34	16.00	5GP1	5.00	12DP7A	45.00	368AS	4.95	730A	22.50	959	2.25
OA3	1.10	2J36	90.00	5J21	75.00	LM15	200.00	371B	1.50	750TL	45.00	E1148	.25
OB2	.99	2J38	8.95	4B26	5.49	15E	1.75	386A	4.50	801A	.90	1280	.35
OB3	1.10	2J39	8.50	4C27	10.00	15R	.75	388A	1.80	802	5.95	1500T	125.00
OC3	.56	2J40	29.50	4C35	35.00	NE16	.50	394A	7.50	803	5.95	HK1554	75.00
OD3	.89	2J42	135.00	4E27	16.00	20-A	.75	394A	3.95	805	6.95	1603	5.00
CIB	2.95	2J49	60.00	4J25	50.00	KY21A	8.25	MX408U	.50	807	1.25	1612	1.50
1B22	1.50	2J50	55.00	4J26	50.00	BK21	2.50	417A	15.00	808	1.95	1613	1.25
1B23	6.95	2J55	150.00	4J27	50.00	RX21	8.00	434A	15.00	809	2.95	1616	1.25
1B24	9.00	2J56	110.00	4J28	50.00	KH24G	1.50	446A	1.95	810	10.50	1619	.45
1B26	1.75	2J61	20.00	4J29	50.00	25T	2.95	446B	3.95	811A	3.75	1622	1.50
1B27	15.00	2J61A	25.00	4J30	30.00	35T	4.95	450TL	45.00	812A	3.95	1624	1.75
1B38	35.00	2J62	15.00	4J31	150.00	35TG	5.95	450TH	52.50	813	13.75	1625	.35
1B50	23.00	2K22	29.00	4J32	150.00	RK39	2.75	464A	7.50	814	1.75	1626	.25
1B51	7.50	2K23	15.00	4J33	150.00	HF3	1.75	471A	1.25	815	3.25	1654	2.75
1B56	35.00	2K25	39.50	4J34	500.00	HK54	4.50	527	24.00	816	1.45	1851	1.00
1B60	35.00	2K26	68.00	4J35	150.00	RK78	1.00	704A	1.95	836	3.95	2000T	150.00
1N21	.55	2K28	35.00	4J36	150.00	RK79	1.00	WL530	23.00	837	2.75	2050	1.00
1N21A	.95	2K29	35.00	4J37	150.00	FG95	19.95	WL531	22.50	838	5.95	2051	1.00
1N21B	1.50	2K33A	75.00	4J38	150.00	100TH	7.95	WL533	15.00	839B	12.50		
1N21C	12.50	2K39	140.00	4J39	150.00	FG105	20.00	HK654	35.00	830B	2.00		
1N22	.66	2K41	135.00	4J40	150.00	122A	1.75	700A/D	18.00	832A	9.95		
1N23	.90	2K42	180.00	4J41	150.00	203A	7.50	701A	4.50	833A	40.00		
1N23A	.90	2K43	190.00	4J42	190.00	211	.95	703A	1.95	834	7.50		
1N23B	1.50	2K44	195.00	4J51	190.00	217C	12.00	704A	1.95	836	5.95		
1N23C	7.50	2K45	80.00	4J52	225.00	242C	16.00	705A	2.75	837	2.75		
1N25	4.50	2K48	95.00	4J53	225.00	244	9.50	706AY/	25.00	838	5.95		
1N26	6.75	2K50	295.00	5BP1	3.95	249C	4.25	707A	5.57	849	35.00		
1N27	3.50	2K54	35.00	5BP2A	12.00	250TH	19.95	707B	6.57	857B	150.00		
1N34A	.79	2K55	25.00	5BP4	3.95	250TL	19.95	714AY	36.00	860	3.50		
1N38	1.00	2K56	72.00	5CP1	7.50	252A	3.00	715A	4.50	861	25.00		
1N43	2.25	3AP1A	10.50	5CP7	9.95	275B	1.00	715B	9.00	866A	1.50		
IP25	75.00	3BP1	7.20	5CP7A	10.00	304TH	10.00	715C	15.00	869B	67.50		
2C39A	13.50	3B24	5.50	5CP12	15.00	304TL	12.50	717A	1.50	869BX	50.00		
2C50	12.00	3B25	5.00	5D21	10.00	307A	2.50	719A	15.00	872A	1.50		
2C43	14.50	3B26	5.00	5JP1	27.50	310A	4.50	720AY/		874	2.25		
2C44	.60	3B28	8.00	5JP2	19.50	310B	6.75	GY	50.00	878	1.50		
2C46	7.50	EL3C	5.50	5JP4	27.50	311A	6.50	721A	1.50	879	.50		
2D29	.99	3C22	75.00	5J23	25.00	312A	1.50	721B	7.50	884	1.50		
2IA	12.00	3C24	1.75	5LP11A	25.00	323A	15.50	723A/B	18.00	885	1.50		
2J22	9.00	3C31	2.55	5RP7	90.00	327A	3.75	724A	1.95	902P1	6.75		
2J26	15.00	3DP1	7.50	C6A	11.00	325A	6.75	724B	2.25	931A	5.00		
2J27	15.00	3DP1A	10.00	C6J	7.50	350A	4.50	725A	18.00	954	.35		
2J31	24.00	3DP1A	5210.00	7BP7	5.50	350B	5.00	726A	10.00	955	.50		
2J32	29.00	3EP1	5.00	7DP4	9.00	HK354C	15.00	726B	45.00	956	.75		
2J33	32.00	3E29	15.50	12AP4	50.00	357A	15.00	726C	45.00	957	.25		
										958A	.60		

VARIOUS 5000 AND 6800 SERIES OF NEW PRODUCTION

5820	475.00
5826	450.00
8012	2.00
8012A	2.50
8013	3.00
8013A	3.50
8019	1.75
8020	1.85
8025	3.57
PD3865	96.00
9001	1.52
9002	.90
9003	1.25
9004	.35
9005	2.75
9006	.25

THOUSANDS OF OTHER TUBES

Special! TS45 X BAND GENERATOR—$99.00

NEW UNUSED SURPLUS TS 259 K BAND
23400-24500 MEGACYCLES SIGNAL GENERATOR

SPECIAL! 5,000 V. POWER SUPPLY
For IP25 Infrared Image Converter from 3 V. Battery Source. NEW, Complete with RCA 1654 Tube..... **$9.90**

NEW MICROWAVE TEST EQUIPMENT
TS148/UP SPECTRUM ANALYZER

TS147 SIGNAL GENERATOR

Field Type X Band Spectrum Analyzer. Band 8430-9780 Megacycles.

Will Check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q of resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

OTHER TEST EQUIPMENT USED CHECKED OUT SURPLUS

TSKI/SE	TS5/AP	TS108	TS226	
TS3A/AP	TS3C/AP	TS110/AP	TS239A-TS239C	SURPLUS EQUIP.
RF4/AP	1-96A	TS125/AP	TS251	APA10
TS12/AP	TS-45	TS126/AP	TS258	APA38
TS15/AP	TS47/APR	TS127	TS278	APS 3 APS 4
TS16/AP	TS49/AP	TS174/AP	TS418	APR4
TS33/AP	TS100	TS175/AP	TP598/1	APR5A
TS34/AP	TS102A/AP	TS182	834	APT2-APT5

SPECIAL
RESONANCE CHAMBER

TYPE CAOT-14 AAT including sweep motor crystal 1N23 with holder and output plug. New.... **$32.50**

Minimum Order 25 Dollars

Phone: ORegon 4-7070

LIBERTY ELECTRONICS, INC.

119 PRINCE ST.
NEW YORK 12, N. Y.
Cables: TELSERUP

WESTINGHOUSE AB De Ion 3 pole, 6 amp 250 V AC E frame. Original cartons. **$5.00 ea.**

HEINEMANN 3XAM1510 3 pole, 5 amp 400 cycle 115 V AC curve 3. Original cartons. **7.00 ea.**

LEO SAGAL CO.
860 GLENMONT, L. A. 24, CALIF.

SPECIAL
20,000 — 5A6 TUBES
TUNGSOL — NEW — JAN
200 to Carton—Min. Order 200 Tubes
25¢ ea
FS-1127, ELECTRONICS
330 W. 42 St. New York 36, N. Y.

CONDENSER SPECIALS

.02 mfd—2000 V Mica $.98
13 amps. @ 1000 KC

1 mfd—15 KV..... $26.95
Qua. disc.—Pyranol

1 mfd—500 V..... $ .19
Bot. Term. Channel—Pyranol

1 mfd—7500 V..... $14.50
New—Ind. Cartoned—Qua. disc.

Mfd	Volts	Price
.001	50KV	24.94
.002	35KV	13.65
.005	15KV	9.75
.005	25KV	20.95
.005	50KV	25.95
.01	10KV	4.95
.012	25KV	12.95
.015	16KV	14.50
.02	5000	.79
.02	8000	4.75
.02	10KV	5.25
.02	20KV	10.95
.025	50KV	22.95
2x.025	50KV	34.50
.03	7500	4.50
.03	16KV	8.50
.03	30KV	25.50
.04	17KV	14.95
.05	7500	2.95
.05	20KV	14.95
.05	25KV	18.95
.05-.05	12KV	9.95
.075	16KV	12.50
.08	12.5KV	8.95
.1	1250	.29
.1	1500	.35
.1	2000	.45
.1	2500	.89
.1	2500	.98
.1	3000	.69
.1	3000	1.15
.1	4000	1.29
.1	5000	1.95
.1	6000	2.15
.1	7500	.85
.1	7500	4.25
.1	10KV	6.35
.1	12KV	6.95
.1	50KV	49.50
2x.1	2000	.89
2x.1	7000	1.50
2x.1	6000	2.29
.15	65KV	73.50
.2	10KV	8.50
.2	13KV	16.50
.2	15KV	13.90
.2	50KV	49.50
.3x.2	4000	2.85
.25	1500	.85
.25	2000	.98
.25	3000	1.45
.25	4000	1.98
.25	6000	.85
.25	15KV	14.95
.25	20KV	16.95
.25	25KV	40.00
.25	32KV	49.50
.25	35KV	55.00
.25	50KV	62.95
.3	2000	.59
.00025	1200	.19
.00025	2500	.35
.00025	5000	1.95
.00027	1200	.27
.00027	2500	.36
.0003	600	.23
.0003	2500	.36
.0004	600	.23
.0004	1200	.29

Mfd	Volts	Price
.3	35KV	57.50
2x.25	2000	1.10
.4	10KV	10.90
2x.4	7500	5.25
.5	600	.39
.5	1500	.55
.5-.1	2000	.35
2x.5	600	.69
2x.5	9000	12.95
5	4K V	8.75
.5	25KV	45.95
.65	12.5KV	13.95
1	500	.55
1	1000	.69
1	1500	.99
1	2000	1.85
1	2500	2.20
1	3000	2.95
1	5000	4.25
1	6000	5.95
1	7500	8.95
1	7500	14.50
1	10KV	23.50
1	15KV	26.95
1	20KV	45.95
1	25KV	49.50
1	25KV	65.00
1	25KV	75.00
1.5	15KV	49.50
1.5	25KV	79.50
1.75	330AC	.69
2	600	.55
2	600	.65
2	1000	.79
2	1000TLA	1.29
2	1500	1.15
2	2000	2.88
2	2500	3.45
2	3000	4.25
2	4000	7.50
2	5000	17.50
2	7500	21.95
2	12.5KV	69.50
2	20KV	89.75
2x3	600	.85
3	1000	.98
3	2000	2.50
3	4000	6.00
3	15KC	80.00
3x3	400	.65
4	500	.55
4	600	.79
4	600TLA	.98
4	1000	1.89
4	1500	2.65
4	2000	2.95
4	2500	4.95
4	3000	6.99
4	4000	15.95
4	5000	24.95
4	7500	39.95
4	10KV	66.95
5	220AC	1.15
5	330AC	1.39
5	600	1.19
5	1000	1.89
5	1500	1.98
5	5000	27.50
2x5	400	.89
2x5	600	1.19
3x5	400	1.29
6	600	1.69
6	330AC	1.69
6	1000	2.39
6	1500	2.95
7	110AC	.79
7	600	.98
7	600	1.35
7	800	1.75
7	5000	29.95
8	110AC	.75
8	500	.89
8	600	1.49
8	660AC	4.25
8	800	1.89
8	1000	2.78
8	1400	1.95
8	1500	3.65
8	2500	6.50
2x8	600	1.89
10	400	.89
10	600	1.19
10	660	2.25
10	1000	3.75
10	1500	4.25
10	2000	5.95
12	660AC	3.75
14	50	.98
15	330AC	1.50
15	400	1.29
15	440AC	3.85
15	1000	3.95
15	1500	5.40
15	5000	99.50
20	330AC	2.35
20	660	1.69
24	500	1.89
25	150	1.39
28	1500	6.95
30	330AC	5.25
30	600	3.95
30	2500	12.95
50	330AC	6.50
70	220AC	6.50
80	4000	45.50

TRANS. MICA CONDENSERS

Mfd	Wvdc	Price
.00001	600	.29
.000024	2500	.35
.000025	1200	.29
.00003	600	.24
.00003	1200	.29
.00003	2000	1.25
.00003	2500	.35
.000047	2500	.36
.00005	600	.23
.00005	1200	.29
.00005	2500	.33
.00005	3000	1.25
.000051	5000	1.75
.00007	2500	.26
.000075	5000	1.45
.0001	600	.24
.0001	1200	.27
.0 001	2500	.36
.00 01	5000	1.95
.00015	600	.23
.00015	2500	.33
.00015	5000	1.95
.0002	600	.23
.0002	1200	.29
.0002	2500	.34
.0002	5000	1.95
.00025	600	.23
.00025	1200	.19
.00025	2500	.35
.00025	5000	1.95
.00027	1200	.27
.00027	2500	.36
.0003	600	.23
.0003	2500	.36
.0004	600	.23
.0004	1200	.29
.0004	2500	.41
.0004	5000	1.95
.00047	2500	.39
.0005	600	.23
.0005	1200	.29
.0005	2500	.39
.005	3000	1.25
.0005	5000	2.45
.005	7500	2.95
.0062	3500	1.25
.00068	2500	.38
.00089	1200	.28
.001	600	.23
.001	1200	.32
.001	2500	.49
.001	4500	1.65
.001	5000	2.25
.001	8000	3.98
.0015	600	.23
.0015	2500	.53
.0015	5000	2.25
.002	600	.27
.002	1200	.29
.002	2500	.63
.002	5000	2.25
.002	6000	2.49
.0024	5000	2.25
.0025	600	.28
.0025	1200	.43
.0025	2500	.65
.003	600	.31
.003	1200	.52
.003	2500	.73
.003	5000	1.65
.003	5000	2.25
.004	600	.29
.004	1200	.48
.004	2500	.91
.005	600	.35
.005	1200	.45
.005	2500	.98
.005	3000	1.65
.006	600	.39
.006	1200	.55
.006	3500	1.65
.0062	2500	.54
.0075	3000	1.75
.008	600	.35
.008	1200	.57
.01	600	.48
.01	1000	.59
.01	1200	.69
.01	1250	.69
.01	2500	.94
.012	1200	.64
.014	600	.45
.014	1200	.64
.015	600	.55
.015	2000	1.75
.02	600	.75
.02	1200	.98
.02	2000	.98
.025	600	.45
.03	600	.65
.03	1200	1.18
.03	2000	1.98
.039	600	.67
.05	1600	1.95
.025	250	1.95
.1	600	.25
2x.1	250	1.98
.115	2000	4.65

BATHTUB CONDENSERS
— ALSO —
PILLAR MICA & CHANNEL CONDS.
CARBON & WW. POTS.
POWER RESISTORS & RHEOS.

MONMOUTH
RADIO LABS.
Box 159 *Capital 2-2776* Oakhurst, N. J.
A. & T. HANKINS, *Owner*

ELECTRONIC

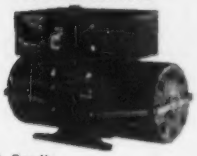
WAR TERMINATION INVENTORIES

WRITE OR WIRE FOR INFORMATION ON OUR COMPLETE LINE OF SURPLUS ELECTRONIC COMPONENTS. ALL PRICES NET F.O.B. PASADENA, CALIFORNIA

C&H SALES CO.

2176-E East Colorado St.
Pasadena 8, California
RYan 1-7393

INVERTERS



10042-1-A Bendix
DC input 14 volts; output: 115 volts; 400 cycles. 1-phase; 50 watt **$35.00**

12116-2-A Bendix
Output: 115 VAC; 400 cyc; single phase; 45 amp. Input: 24 VDC, 5 amps. **$35.00**

12117 Bendix
Output: 26 volts; 400 cycles, 6 volt amperes, 1 phase. Input: 24 VDC; 1 amp. **$15.00**

12121 Bendix
Input: 24 volt D.C. 18 amp. 12000 r.p.m. Output: 115 volts, 400 cycle, 3-phase, 250 volt amp, 7 pf. **$49.50**

12123 Bendix
Output: 115 V; 3-phase; 400 cycle; amps .5 Input: 24 VDC; 12 amp. **$49.50**

12126-2-A Bendix
Output: 26 volts; 3 phase; 400 cycle; 10 VA; .6 PF. Input: 27.5 volts DC; 1.25 amps. **$24.50**

12130-3-B Bendix
Output: 125.5 VAC; 1.5 amps. 400 cycles single phase, 141 VA. Input: 20-30 VDC. 18-12 amps. Voltage and frequency regulated. **$49.50**

12133 Bendix
Input: 26/29 volt D.C., 28 amps Output: 115 volt, 3 phase, 400 cycle, 250 volt amp., .8 pf. **$59.00**

12143-2-A Bendix
Output: 115 volts; 400 cycles; 250 VA; single phase pf. 9-1. DC Input: 26-29 VDC; 25-22 amp; voltage & frequency regulated **$49.50**

778 Bendix
Output: 115 volt, 400 cycle; 190 VA; single phase and 26 volt, 400 cycle, 60 VA, single phase. Input: 24 VDC. **$37.50**

10285 Leland
Output: 115 volts AC; 750 VA, 3 phase, 400 cycle, .90 pf and 26 volts, 50 VA, single phase, 400 cycle, .40 pf. Input: 27.5 VDC, 60 amps. cont. duty, 6000 rpm. Voltage and frequency regulated. **$59.50**

10339 Leland
Output: 115 volts; 190 VA; single phase; 400 cycle; .90 pf. and 26 volts; 60 VA; 400 cycle, .40 pf, Input: 27.5 volts DC, 18 amps cont. duty, voltage and freq. regulated. **$49.50**

10486 Leland
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 pf. Input: 27.5 DC; 12.5 amps; cont. duty. **$70.00**

10563 Leland
Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 pf. Input: 28.5 VDC; 12 amps. **$35.00**

PE109 Leland
Output: 115 VAC, 400 cyc; single phase; 1.53 amp; 8000 rpm. Input: 13.5 VDC; 29 amp. **$50.00**

PE218 Leland
Output: 115 VAC; single phase pf 90; 380/500 cycle; 1500 VA. Input: 25-28 VDC; 92 amps; 8000 rpm; Exc. Volts 27.5 BRAND NEW. **$30.00**

MG149F Holtzer-Cabot
Output: 26 VAC @ 250 VA; 115 V. @ 500 VA; single phase; 400 cycle; Input: 24 VDC @ 36 amps. **$40.00**

MG153 Holtzer-Cabot
Input: 24 VDC; 52 amps. Output: 115 volts — 400 cycles, 3-phase, 750 VA. Voltage and frequency regulated. **$95.00**

DMF2506M Continental Electric
24-30 volts input; 5.5-45 amps; cont. duty. Output: 115 volts; .44 amps; 400 cyc; 1 phase; pf 1.0; 50 watts. **$35.50**

ROTARY JOINT

Contains 4 slip rings; rated at 3 amps at 110 VAC. Model No. RPJ-E-11. Manufactured by Selectar Mfg. Corp. Approximately 3" in diameter, 3⅛" long. Priced at **$3.00 each.**

SELSYNS-SYNCHROS

1CT Cont. Trans. 90/55V 60 cy.	$37.50
1DG Diff. Gen. 90/90V 60 cy.	37.50
1F Syn. Mtr. 115/90V 60 cy.	37.50
1G Gen. 115V 60 cy.	37.50
1SF Syn. Mtr. 115/90V 400 cy.	$12.50
2J1F1 Gen. 115/57.5V 400 cy.	7.50
2J1F3 Gen. 115/57.5V 400 cy.	10.00
2J1FA1 Gen. 115/57.5V 400 cy. 57.5/57.5V 400 cy.	7.50 / 5.00
2J1H1 Diff. Gen. 57.5V 400 cy.	7.50
2J5D1 Cont. Trans. 105/55V 60 cy.	17.50
2J5F1 Cont. Trans. 105/55V 60 cy.	17.50
2J5H1 Gen. 115/105V 60 cy.	17.50
2J15M1 Gen. 115/57.5V 400 cy.	17.50
5CT Cont. Trans. 90/55V 60 cy.	34.50
5D Diff. Mtr. 90/90V 60 cy.	34.50
5DG Diff. Gen. 90/90V 60 cy.	34.50
5F Syn. Mtr. 115/90VAC 60 cy.	34.50
5G Syn. Gen. 115/90VAC 60 cy.	34.50
5HCT Cont. Trans. 90/55V 60 cy.	42.50
5SDG Diff. Gen. 90/90V 400 cy.	12.50
6DG Diff. Gen. 90/90V 60 cy.	25.00
6G Syn. Gen. 115/90VAC 60 cy.	34.50
7G Syn. Gen. 115/90VAC 60 cy.	42.50
R110-2A Kearfott Cont. Mtr. 115V 400 cy.	17.50
R200-1-A Kearfott Cont. Trans. 26/11.8V 400 cy.	15.00
R210-1A Kearfott Trans. 26/11 8V 400 cy.	15.00
R235-1A Kearfott Resolver 26/11 8V 400 cy.	22.50
C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type I-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type II-2 Rep. 115V 60 cy.	20.00
C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
C78249 Syn. Diff. 115V 60 cy.	5.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 32V 60 cy.	7.50
403 Kollsman Autosyn Mtr. 32V 60 cy.	7.50
CK5 Bendix Mtr. 2 phase 26V 400 cy.	17.50
FPE-25-11 Diehl Servo Mtr. 75/115V 60 cy.	22.50
FPE-43-1 Resolver 400 cy.	25.00
FJE-43-9 Resolver 115V 400 cy.	25.00
999-0411 Kollsman 26V 400 cy.	15.00
1377-0410 Kollsman 26V 400 cy.	10.00
15158-0410 Kollsman 26V 400 cy.	20.00
10047-2-A Bendix 26V 400 cy.	12.50
2900 Transicoil 115V 400 cy.	15.00

ESTERINE ANGUS RECORDER

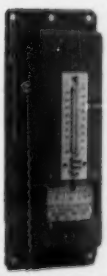
Model AW 0-1 MA

DC Milliameter permanent magnet moving coil type. Spring clock duel speed drive (hour and minute). Instructions including connection diagrams and instrument data sheet with each instrument. Portable case **$290.00**

APG 15 INDICATOR

Easily converted to a MODULATION INDICATOR. Unit contains a 2AP1 tube with shield; also 9006 tube, miscellaneous potentiometers and resistors. Brand new.....**$5.00 each**
Conversion data to miniature modulation indicator with schematic.....**$1.50**

TEMPERATURE and HUMIDITY INDICATOR



(Hair actuated) Manufactured by Freos Instruments. Model No. 181-1. Approximately 7¼" high by 5" wide. Priced at **$3.95 each.**

SMALL DC MOTORS

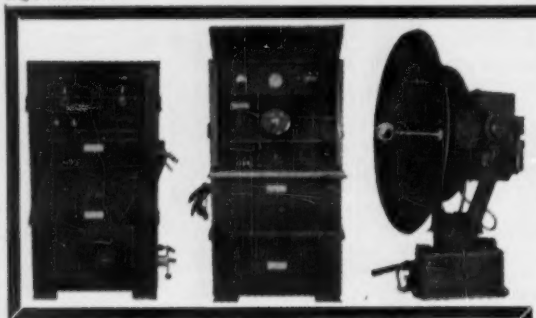
(approx. size overall 3¾" x 1¼" dia.)	
5069600 Delco PM 27.5 VDC 250 rpm	$12.50
5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w/brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069625 Delco 27.5 VDC 120 rpm w/governor	15.00
MM A-11 Globe PM 24 VDC	7.50
5BA10AJ18 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
806069 Oster series reversible 1/50 h.p. 10,000 rpm 27.5 VDC 1⅛" x 3½"	5.00
C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm	3.00
7100-B PM Hansen 24 VDC 160 rpm	7.50
SSFD-6-1 Diehl PM 27.5 VDC 10,000 rpm	4.00
6-volt PM Mtr. mfgd. by Hansen 5,000 rpm 1¼" in dia. 2" long overall	4.00

WANTED
RT-66, 67, 68, 69, 70 GRC
AN/PRC-8, 10 AN/PRC-6
R-109-110 GRC PARTS AND COMPOPONENTS OF AN/GRC EQUIPMENT

Radalab Inc.

81-17 124TH ST. RICHMOND HILL 18, NEW YORK, N. Y.

Phone Virginia 9-8181-2-3
TWX-NY-4-4361



SCR-682-A SEARCH AND WEATHER RADAR

This is a 10cm high power search and weather radar, using a 7" P.P.I. These sets will give excellent SERVICE IN A TORNADO OR STORM WARNING NETWORK, OR AT AN AIRPORT for surveillance to 135 miles. The set consists of three units. 1—The paraboloid antenna which includes the pedestal, reflector, dipole and RF section. 2—Modulator. 3—Desk type P.P.I. indicator, units have pullout decks that enable the set to be serviced without being taken out of operation and are fully safety interlocked.

Technical Specifications:
1—Operating freq.—3000cm 10mc.
2—Power output—225kw.
3—Pulse width—1 micro second.
4—ranges—500-240,000 yds in four ranges. 10,000 yds, 40,000 yds, 160,000 yds, and 240,000 yds.
5—360 scan.
6—azimuth accuracy 1°.
7—7" P.P.I. indicator.
8—Antenna beam width 1°.
9—110v 60 cyc power input.

THE SCR-682-A IS AVAILABLE IN OPERATION BY APPOINTMENT.

AN/APN-3 - AN/CPN-2 SHORAN

The AN/APN-3 and AN/CPN-2 are airborne and ground. Precision distance measuring installations. This equipment operates on 225 mc. The range is 250 miles with an accuracy of 25 feet. This is the most accurate distance measuring equipment built to date. The AN/APN-3 used with the K-1 computer (also available) will permit taking a photograph up to 250 miles from the CPN-2 beacons completely automatically. The AN/APN-3 can be fed into the aircraft auto pilot to fly it to the drop point. This equipment is very widely used by geological survey companies for oil prospecting and mapping. Power input is 110v 400cyc and 28v DC. COMPLETE SETS AND SPARES ARE AVAIL.

AN/ASQ-1
Airborne Magnetometer

This is an airborne chart recording magnetometer. The set consists of an amplifier, oscillator, detector head, chart profile recorder, power supply, etc. The equipment has a sensitivity of 2 gamma or better. The AN/ASQ-1 records on an Esterline ANgus recorder disturbances in the earths magnetic field caused by an ore deposit or a sunken boat or submarine. An indicator is provided that gives a bearing on a magnetic disturbance. Power input is 28v DC. Weight about 150 lbs.

REMOTE P.P.I.s

VD 7" Upright Mount
VE 7" Table Mount
VF 9" Upright Mount
VG 24" Plotting Table
VJ 12" Upright Mount
VK 12" Upright Mount
VL 12" Upright Mount

OTHER EQUIPMENT

AN/URC-4
Airsex rescue set
AN/ARC-12 and up
AN/APG-15 and up
AN/APS-19 and up
AN/APR-4, 5, 6 and up
AN/CPN-6, 8, 17 Beacons
AN/UPN-1, 2, 3, 4, Radar Beacons
SCR-395, 499
SCR-536
SCR-300
SCR-506
SCR-508, 608
Test Sets TS-1 to TS-700
"If It Is Or Was Made We Can Supply It"

AN/PRC-8, 10 WALKIE-TALKIE

The PRC series are the new F.M. high freq. back pack walkie-talkies. These sets are miniaturized and weigh 18 lbs. complete. The PRC-8 covers 20-27.9 mc. PRC-10 covers 38-54.9 mc. The set has 16 tubes. The receiver is A.F.C. controlled and has a sensitivity of .5 microvolts. The transmitter output is 1 watt F.M. A crystal calibrator is provided to calibrate the set. The receiver is equipped with a squelch control. Complete sets and parts available.

AN/GRC-3 thru 8

The GRC series are the new field and mobile military communications sets. These sets cover 26-58.4 mc. The transmitter output is 15 watts. The transceivers are tuneable or fixed. Input is 12 or 24v DC. Components are miniaturized. Complete installations are avail. Also parts..

SCR-616 — BC-1269

F.M. & A.M. 145-600mc communications receiver. The receiver is a superhet covering the 145-600mc in 2 bands. The dial is calibrated in megacycles. F.M., or A.M. reception is offered. Input is 110v 60 cyc. This is one of the nicest receivers designed.

FAIR RADIO SALES • 132 SOUTH MAIN ST LIMA, OHIO

RECEIVER—TRANSMITTER
FM 20 — 28 MC

BC-603 RECEIVER: 20-28 MC variable tuning, 10 Pre-Set push button channels, squelch circuit, 4" speaker; 10 Tubes: 3/12SG7, 2/6SL7, 1/6V6, 1/6J5, 3/6AC7, & 1/6H6. Prices: ..... NEW: $39.95 USED: $29.95

PLUG for rear of Receiver $1.00

DYNAMOTOR: 12 V input; Output 290 V 80 MA, #DM-34 ..... NEW: $4.95 ..... ReISSUE: $2.95

BC-604 TRANSMITTER: 20-28 MC, 30 Watt, companion to BC-603 Receiver. Crystal control, 10 Pre-Set channels, interphone communication; 5 Tubes: 7/1619 & 1/1634 ..... USED: $18.95

PLUG for rear of Transmitter $1.00

DYNAMOTOR: 12 V input; Output 625 VDC 225 MA, #DM-35 ..... NEW: $12.95 ..... ReISSUE: $8.95

FT-237 BASE for mounting Receiver & Transmitter (No plugs required) ..... USED: $9.95

BC-500 RECEIVER—TRANSMITTER: FM Crystal Control on 5 channels. 100 KC separation 20-28 MC. Transmitter: 25 Watt output. 7 Tubes: 1/1625, 1/12A6, 3/12SJ7, & 2/12SA7. Receiver: 11 Tubes: 1/12SL7, 2/12A6, 3/12SA7, 3/12H6, 2/12K8, & 1/12SJ7. Dynamotor Supply: Receiver 28 VDC 1.2 A input; output 250 VDC 60 MA. Transmitter 28 VDC 4.1 A input; output 550 V 120 MA. Control Panel: For Local Control & outlets for Remote also. Heavy duty 5" speaker. Size: 12" x 25" x 9½". Weight: 65 lbs. Price ..... NEW: $59.50

TELEPHONE EQUIPMENT

EE-8 Field Telephone—Ideal for private telephone system for two or more phones, up to 17 miles, hand ringer generator with handset, carrying case, uses two flashlight batteries. ..... Used, Checked: $14.95 New Equipment, Used Cases: $18.95

RM-13 Remote Control Unit for telephone & radio equipment. Telephone unit same as EE-8; Radio remote, pre-amplifier, 115 V 60 cycle with input & output jacks, DB Meter, one tube amplifier with TS-9 handset. ..... Used: $19.95 — NEW: $24.95

SOUND POWERED HEAD & CHEST SETS Used, Checked: $3.95

TS-9 HANDSETS ..... NEW: $6.95 — USED: $3.95

TS-13 HANDSETS w/PL-55 & PL-68. USED: $5.95

INVERTERS & GENERATORS:

GENERATOR—115 V. 400 Cycle, 1400 Watt, Single Phase, 28.5 VDC 400 Watt. ..... USED: $89.50

GENERATOR: Motor 3 HP. 115/230 60 cycle single phase; Generator 115 Volt 400 cycle single Phase 1400 Watt & 28.5 VDC 400 Watt. Belt Drive. Reconditioned $195.00

115 V. 60 CYCLE BLOWERS:

At Left: 115 VAC 60 Cycle SINGLE TYPE — 100 CFM — 2-½" intake; 2" outlet. Complete size: 5" x 6" — No. 1C939 ..... $8.95

115 VAC 60 Cycle DUAL TYPE —100 CFM—4" intake; 2" Dia. Each Side. Complete size: 8" x 8" — No. 1C880 ..... $13.95

115 VAC 60 cycle COMPACT TYPE—108 CFM; Motor built inside squirrel cage; 4-½" intake; 3-⅝" x 2" Dia. Complete size: 4-⅝" W x 8-⅝" H x 8-⅛" D—No. 2C967 ..... $14.95

115 VAC 60 cycle FLANGE TYPE—140 CFM; 3-½" intake; 2-½" Dia. Complete size; 7-½" W x 7-¼" H x 6-¾" D—No. 1C807 ..... $13.95

115 VAC 60 cycle FLANGE TWIN—275 CFM; 4-½" intake; 3-½" x 2" Dia. Complete size: 11-⅝" W x 8-⅝" H x 8-1/16" D— No. 3C969 ..... $21.95

115 VAC 60 Cycle BLOWER—200 CFM; 4" intake; 2" x 5" outlet. Overall size: 9" x 7" x 6". Bodine Motor NSI-33. Removed from New Equipment. #BOD-200 ..... $14.95

115—VAC 60 Cycle BLOWER—100 CFM; 3-¾" intake; 2" outlet; Rd. Flange with Flap Director. Overall size with bracket; 8" L x 6-½" W x 7" H. Removed from New Equipment. Diehl Motor FB-2106-6 No. FDBL-2106 ..... $6.95

Same as above, but with 12- Curved Director. No. CDBL-2106 ..... $7.95

OTHER BLOWERS:

12/24 VDC—AC CAST ALUMINUM BLOWER—100 CFM—3" intake; 2" outlet. Shunt Motor 4" x 2", 3000 RPM @ 24 VDC $5.95

6 VDC SINGLE—100 CFM—No. 6100—USED: $4.95
24 VDC DUAL—30 CFM—Min—No. 2420 ..... $7.95

10 CFM BLOWER—27.5 VDC; 1/100 HP; 7000 RPM; Oster Motor C2RP-1A; L-R Mfg. Co. Bakelite Blower #2—Overall Size: 3½" x 4½". Price $5.95

Same as Above, 12 VDC operation — Price $5.95

115 V. 400 CYCLE—10 CFM—Eastern Air Devices Motor J31A—7200 RPM. 1/100 HP. L-R #2 Blower Assy. Overall Size: 4-¼" x 3-½". No. 3110 ..... $6.95

10 CFM BLOWER—28 VDC .6 A; 5000 RPM. Pioneer Motor 88-2345. Aluminum Blower Housing — Overall Size: 4½" x 3-½". Price $5.95

NEW LIST: Write today for FREE New Listing of many, many items!

For:

★ Test Sets
★ Airborne Electronics
★ Radar
★ Navigation Aids
★ Parts—Meters—Tubes

WHAT ARE YOUR NEEDS?
Write—wire—or phone.
Immediate reply assured.

VARIABLE VOLTAGE

AMERTRAM TRANSTAT. 11.5 KVA. Input 115 V., 60 cycles. Output continuously variable 0 to 115 V. up to 100 amperes. Easily re-connected for input of 230 V, with output of 0-230 V, 50 amperes. Brand new. Special $99.50

GERMANIUM DIODES

SUPER SPECIAL!
1N70, JAN, New and Clean!
8 for $2.98

Stock up while they last! Extremely high (100) inverse volts. So only 8 are needed to make a full-wave 115 V. bridge (2 in series in each leg, with high safety factor, instead of the usual 3 per leg.) 30 ma average. Also, greatly reduced reverse current: only 300 uA at —50 V! Normally, a very high priced unit, so this is a terrific buy! Next price break is: 1,000 for $325.00.

ARROW SALES, INC.

P. O. Box 3007-E, North Hollywood, Cal.

Phones: STanley 7-0406 POplar 5-1810
Telegraph Address: WUX, No. Hollywood
Cable Address: ARROWSALES, North Hollywood

SAVE ON TUBES BRAND NEW TUBES GUARANTEED TUBES

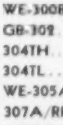
OA2	.75	2J42	60.00	4J52	50.00	203A	3.00	WE-394A	3.00	800	1.50	5517	1.75
OA3	.90	2J48	35.00	4X150A	22.50	204A	25.00	WE-396A	3.00	801A	.50	5551/FG271	25.00
OB2	.65	2J49	40.00	4X500A	55.00	207	25.00	403/5591	2.75	802	2.25	5553/FG258A	90.00
OB3/VR90	.85	2J50	35.00	5BP2A	5.00	211/VT4C	.50	WE-403A	1.50	803	1.40	5559/FG57	10.00
OC3/VR105	.65	2J55	35.00	5CP1A	8.00	212E	15.00	WE-404A	11.00	804	9.00	5586	125.00
OD3/VR150	.65	2J56	50.00	5CP7A	8.00	WL-218	15.00	GL-414	99.50	805	6.00	5591/4038	2.75
ELC1B	1.50	2J61	15.00	5CP11A	9.50	RX-233A	.75	WE-416B	45.00	806	7.50	5611	65.00
1AD4	1.25	2J62	6.50	5C22	29.50	FG-235A	25.00	417A	2.75	807	1.20	5634	7.00
1B23	2.75	2K22	14.50	5C30/C5B	1.00	QK-249	150.00	WE-417A	12.50	807W	3.00	5636	2.25
1B24	5.50	2K23	14.50	5JP2	7.00	WE-249B	2.50	WE-423A	8.50	808	1.25	5647	5.00
1B24A	12.50	2K25	12.00	5JP4	7.00	WE-249C	3.00	446B	2.00	809	2.25	5651	1.40
1B26	1.25	2K26	45.00	5JP5	7.00	250-R	4.00	WL-456	59.50	810	10.00	5654	1.25
1B27	10.00	2K28	25.00	5JP11A	9.50	250-TL	15.00	464A	2.25	813	11.00	5656	7.00
1B35	4.50	2K31	90.00	5MP1	3.95	WE-251A	39.50	527	22.50	814	1.75	5657	125.00
1B36	4.00	2K33A	50.00	5NP1	5.00	WE-252A	7.95	ML-531	4.00	815	1.50	5663	1.50
1B40	2.00	2K33B	110.00	5R4GY	.90	WE-254A	3.75	KU-610	3.50	826	.75	5667	125.00
1B42	4.00	2K34	85.00	5R4WGY	2.75	FG-258A	90.00	KU-627	10.00	829	6.00	5670	1.50
1B47	6.50	2K35	175.00	C6J	6.50	FG-271	25.00	KU-628	10.00	829B	8.50	5687	3.00
1B51	6.75	2K39	100.00	6AK5W	1.00	271A	10.00	648P1	5.00	830B	.75	5691	4.75
1B62	4.00	2K41	100.00	6AN5	2.00	WE-274B	1.00	WL-652	20.00	832	4.00	5702	1.75
1B63A	22.00	2K42	125.00	6AR6	1.25	WE-282A	6.00	HK-654	25.00	832A	6.00	5702WA	6.00
1N21	.60	2K43	110.00	6AS6	1.25	WE-288B	6.00	681/686	25.00	836	1.50	5703	1.10
1N21B	1.25	2K45	40.00	6BL6	35.00	WE-285A	5.00	WE-701A	1.85	842	2.00	5718	3.00
1N23	.60	2K46	200.00	6BM6	25.00	287-A	2.50	702A	.50	845	5.00	5719	2.50
1N23B	1.50	2K47	110.00	6F4	3.25					849	17.50	RK-5721	150.00
1N23BM	3.50	2K48	75.00	6J4	1.95					851	10.00	5725	1.50
1N23C	2.50	2K50	150.00	6J4WA	3.50					852	4.00	5726	.60
1N25	3.00	2K54	7.00	6K4	2.25					858	Q	5727	1.30
1N26	3.75	2K56	50.00	6Q5G	3.25					860	3.00	5744	1.90
1N28	5.00	2K2A	1.00	6L6WGB	2.75					861	15.00	5750	3.10
1N31	3.00	3AP1	2.95	6SK7W	2.00					872A	1.35	5763	1.30
1N34A	.50	3BP1	2.00	6SN7W	2.00					884	1.00	CK-5787	4.95
1N38A	.65	3B24	1.00	6SU7GTY	2.75					GL-889	30.00	5814	1.00
1N42	8.00	3B24W	5.00	6X4W	1.00					GL-889A	65.00	5814WA	3.50
1N52	.65	3B26	2.50	6X5WGT	1.30					889RA	110.00	5819	25.00
1N63	1.75	3B28	5.00	7C22	50.00					902A	3.00	5825	7.95
1N69	.40	3B29	5.50	7C24	90.00					902P1	3.00	5829	1.40
1P21	30.00	3C22	60.00	FG-17	2.95					905	2.00	5829WA	8.00
1P22	6.50	3C23	5.00	RX-21	4.00					917	2.00	5837	70.00
1P28	9.00	3C27	1.00	HK-24	3.00					919	2.00	5840	4.50
1W5	1.00	3C31	1.50	RK-28A	2.50					927	1.00	5844	3.00
1Z2	1.75	3C33	8.00	HK-54	2.00					931A	2.50	5851	4.00
2AP1	4.00	3C45	7.00	D-42	40.00					935	4.00	5876	11.50
2C33	.75	3DP11A	7.50	QK-60	25.00					954	.35	5894	18.00
2C35	2.50	3D21A	3.00	RK-60/1641	1.35					955	.35	5896	5.00
2C36	30.00	3DP1S2	5.00	RK-61	2.50					956	.35	5899	5.00
2C37	30.00	3E29	8.50	QK-62	25.00					957	.35	5901	6.50
2C39	4.95	3FP7A	2.50	HY-65	1.00					958A	.35	5905	8.95
2C39A	10.00	3J30	35.00	RK-65/5D23	7.50					959	1.25	5908	7.95
2C42	10.00	3K22	150.00	FG-67	12.00					991	.35	5932	4.00
2C43	9.00	3K23	150.00	HY69	3.00					CK-1005	.35	5933/807W	4.00
2C44	.50	3K30	100.00	RKR-72	.50					CK-1006	2.75	6005	1.75
2C46	6.00	4-65A	14.00	RKR73	.50					CK-1007	.55	6021	4.50
2C51	3.00	4B23	5.00	ML-100	50.00					1603	3.00	6044	30.00
2C52	3.00	4B24/3C	4.00	100TH	6.50					1620	3.25	6045	Q
2C53	10.50	4B31	22.00	FG-105	11.00					1623	1.75	6046	.75
2D21	.60	4C27	5.00	F-123A	2.95					1624	1.00	CK-6050	2.00
2D21W	1.25	4C28	25.00	F-124A	Q					1625	.30	6096	1.75
2E26	3.25	4C35	13.50	F-128A	13.00					1626	.25	6100/6C4WA	2.25
2E27	.60	4E27	8.75	FG-154	15.00					1636	.75	6111	6.50
2E31	1.00	4J22	35.00	VT158	9.75					1641	1.35	6147	3.00
2J31	15.00	4J29	35.00	FG-166	15.00					1642	.50	6177	49.50
2J32	12.50	4J31	65.00	FG-179	20.00					1945	65.00	6246	Q
2J33	14.50	4J34	50.00	HF-200	10.00					2000T	150.00	6764	Q
2J34	14.50	4J42	25.00	QK-181	20.00					2050	.90	8005	4.95
2J36	15.00	4J50	99.50	WL-200	75.00					2051	.65	8012	1.00
												ZB-3200	69.50	8025A	2.00
														9001	.85
														9002	.55
														9004	.85
														9005	1.50

SPECIAL!

5" DUAL GUN TUBE

Long persistency face, P7 screen. Value at $200.00. This tube has been rejected for military use.

Tested Before Shipped & Fully Guaranteed. Only **$17.95**



VACUUM CAPACITORS

6 mmfd. 30 KV..... 9.00
50 mmfd. 32 KV..... 9.00
75 mmfd. 20 KV.....12.50
Also Other Values!

THIS IS ONLY A PARTIAL INVENTORY. **CHECK WITH US FOR YOUR REQUIREMENTS**

Thousands of other types in stock. Send us your requirements. RECEIVING TUBES! We Carry a complete line in stock. Standard brands only.

jsh SALES CO.

ELECTRONICS
Dept. E-A
1108 Venice Blvd
Los Angeles 15
California

All prices F.O.B. Los Angeles, subject to change without notice. Minimum order $5.00. Check with us for items not listed.

TUBES • ALL FAMOUS ADVERTISED BRANDS ONLY • TUBES

RMA GUARANTEE — From 10% to 95% Below Manufacturers Price — Look and Compare

Special Prices to Quantity Buyers. Most of Our Tubes are Jan.—95% are Original boxed — Brands such as R.C.A., G.E., Ken-Rad, Sylvania, Tung-Sol and Raytheon.

TYPE	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AB/150	$1.00	OB2	.69	3K28	29.50	5BP1	2.49	12AT7	.85	274B	1.79	703A	1.00	815	3.99	5703	1.19
CK1	5.00	1B22	5.00	2K33A	$9.95	5BP4	2.99	12AU7	.76			704A	1.50	826	1.65	5725	1.59
CK2	7.99	1B24	5.99	2K45	72.50	5CL8	1.25	12BE6	.79	282A	6.49	705A	1.25	826	.75	5810	.29
CRP RK-73	.49	1P28	1.99	2K54	8.95	5CP1	25.00	12BA7	1.00	286A	7.50	706A	6.75	829	7.50	5814	.29
EC1	1.99	2AF/G	1.25	2K55	9.50	5CP1A	12.49	12BA7/GT	2.99	287A	6.45	706B	14.50	829B	8.99	5826	.29
EF-86	.88	2AP1	1.25	2V3/G	1.39	5CP7A	12.49	12CG6	1.15	304TH	16.00	706C	17.50	829C	2.99	5839	.29
EL148	.79	2AP1A	6.44	3A4	.49	5CP11	49.50	12DQ6	1.49	304TL	12.00	707A	3.50	832A	7.49	5840	.29
EM-1GA	39.50	2BP1	5.99	3A5	.49	5CP11A	14.99	12BP7	6.25	307A	1.85	707B	4.45	833A	17.50	5841	1.69
F193A	5.99	2BP11	7.99	3AP1	3.99	5DP1	6.99	12LP7	5.99	310A	3.99	708A	2.35	836	1.99	5842	.29
F218A	18.00	2C22	.79			5FP7	2.99	16Y	.39	316A	.69	709A	1.49	837	1.99	5844	.49
FG-105	12.99	2C26	.79	3AP1	3.99	5HP1	2.49	12X3	1.69			713A	1.95	838	1.99	5845	4.99
FG-154	14.99	2C26A	.79	3B22	1.47	5JP1	14.99	13C	.39	327A	4.50	714AY	24.50	841	1.99	5845W	2.49
HF-100	7.49	2C39	4.99	3B24	1.99	5JP2	14.99	24H	1.69	329A	4.69	715A	2.65	843	.49	5847	.49
HK-24	1.69	2C39A	11.50	3B24W	4.99	5JP7	7.99	35T	4.99	347A	3.85	715B	6.45	845	6.49	5863	1.19
HK-54	1.69	2C40	9.99	3B25	1.99	5JP11	14.99	35TG	7.25	350B	7.45	715C	14.50	860	16.50	5881	1.19
HY-114B	.69	2C42	9.75	3B27	1.69	5LP1	13.99			356B	7.45	717A	.49	865	3.49	5894	1.49
KU-610	6.99	2C43	10.99	3BP1	1.49							18AY/GY/ GY/GV	19.75	866	1.49	5932	4.25
MY-60	1.99	2C44	1.15	3BP1A	1.55							719A	14.45	868	.49	5670	2.25
REL-23	1.00	2C46	1.49	3C22	44.50							721A	.49	869A	1.19	5685	1.79
RK-34	.39	2C48	7.49	3C23	6.99							722A	1.49	869B	30.00	5762	1.49
												723A/B	8.50	872A	1.29	5762WA	3.10
																5726	1.00

CRYSTAL DIODES

1N21	.10	1N23B	1.10
1N21A	.55	1N25	1.55
1N21B	.95	1N27	.65
1N22	.45	1N34	.65
1N22A	.49	1N34A	.95

LARGEST SURPLUS DEALER IN USA

RK-59	1.65	2C51	9.98	3C24	1.50	5NP1	6.99	6S8	2.29	371B	1.39	724A	1.15	878	.69	5744	.95
RK-60	1.99	3D21	.69	3C33	8.99	6C21	19.95	6SY	.35	388A	1.49	724B	1.45	878	.98	5751	2.10
RK-61	3.50	3D21W	1.35	3C45	6.25	6AC7	1.00	6SETH	1.99	392A	4.35	725A	3.99	885	1.00	5763	1.19
RK-62/5D22	14.99	3E22	2.25	3CP1	2.25	6AC7W	1.50	6U7A	1.99	394A	2.99	726A	5.50	914	1.10	5814	1.10
RK-72	.69	3G22	2.99	3DP1	2.25	6AG7	.70	6U8A	1.99	WL-417A	3.99	726B	25.00	927	1.49	5879	1.10
RK-233A	.49	3G23	4.95	3E29	19.25	6AJ5	1.10	6V6GT	.69	GL-434A	6.65	726C	34.50	927A	1.95	5881	2.95
VT6/2A	.49	3J27	5.99	3EP1	1.55	6AK5	.79	6X4	.77	446A	1.45	730A	7.95	927B	1.49	5963	1.10
VT25/10	.49	3J28	14.50	3EP1A	1.55	6AK5W	1.49	6X5	.77	446B	1.75	731A	3.29	931A	2.50	5965	1.10
VT25A/10Y	.49	3J31	14.50	3FP1	1.55	6AN5	1.25	6Y6G	1.49	WL-460	8.99	800	.39	954	.29	6060	1.50
VT61/10 Spec.	.49	3J32	14.50	3J21	49.95	6AS6	1.10	6Z4	.49	WL-464A	4.25	801A	.39	955	.29	6060W	1.90
VT-105	17.50	3J33	14.50	4-65A	39.50	6AS7/G	2.49	7AD7	1.49	CK-508AX	1.10	802	2.49	956	.29	6082B*	15.00
WU-33	1.49	3J34	14.50	4-125A	39.50	6BA6	39.50	7AF7	1.10	CK-521AX	1.10	803	2.69	957	.29	6146	4.50
1612/532A	.39	3J36	14.50	4A-33	4.99	6BE6	.79	7AG7	1.25			804	9.99	958A	.39	6012	1.85
GK-59	29.50	3J38	14.50	4AP10	4.99	6CB6	1.49	7AU7	1.25	WL-530	19.50	805	4.50	959	.29	6080	1.49
GK-61	32.00	3J49	19.50	4B22	6.49	6D4	2.99	7BD6	1.49	WL-531	6.25	806	1.75	9001	.29	6146W	5.50
GK-185	99.00	3J61	16.40	4B25	7.55	6F4	2.00	7BH7	1.25	532A	.59	807	2.15	9002	.29	6211A	1.49
VR-75	.55	3J62	9.60	4B26	4.69	6F6	2.00	7BK7	2.25	700A/B/C/D/ E	10.95	807W	3.25	CK1005	.45	6020	1.39
VR-90	.65	3K22	14.50	4B27	1.95	6J4	2.50	7BQ6	4.99			808	1.75	CK1006	3.97	6021	1.39
VR-105	.75	3K27	14.50	4C35	1.95	6J4W	3.75	7BR8	4.49	701A	4.99	809	3.15	1500T	54.50	9001	.79
VR-150	.75	3K28	10.95	4E27	1.95	6J6	1.29	7BW6	1.49	702A	2.25	810	9.95	1608	2.99	9002	.69
OA2	.74			5AP1	1.55	6J6W	1.29	7BZ6	1.49			811	2.19	1613	.35	9003	.69
						6K4	3.99	7C5	1.98			811A	2.45	1614	1.49	9004	.39
						6K4W	1.49	7F4	12.50			813	11.45	1616	.59	9006	.39
						12A6	.59	7F8	1.49			814	2.69				

COAX CONNECTORS

831SPN — PL259A 28¢

SO239 24¢ 831R

M359A 15¢ 831AD

FAY-BILL DISTRIBUTING CO. DEPT. E1
418 Broome St., N. Y. 13, N. Y.
Telephone CAnal 6-8404

All boxed and fully guaranteed. Special quantity discount—10% on 100 or more of same type. Minimum order $10.00. Thousands of other types in stock . . . Send us your requirements. F.O.B. New York 25% deposit with order or if paid in advance save C.O.D. charges. Rated firms net 10 days. Prices subject to change without notice. For fast service ask for Sy.

SELLING

Receivers
Transmitters
Radar
Special Purpose Tubes
Relays
Meters
Switches
Connectors
Rectifiers
Transformers
Motors & Generators
Wiring Cable
Instruments
and
All Electronic Components

WILL BUY ALL

New or Used

Leach, Relay #5059-R
#5058
#5055
#5053-SM
#5053

Price Bros. Relay #10
Relay #5586
#5587

Antenna Switching Relay
Box # CBY 23049
BG-AN-198
BC -408

Tubes #53A
VT-127A
35T
WL-530

Highest prices paid for most all types of aircraft sparkplugs any condition

Wholesale Only

RADIO & ELECTRONIC SURPLUS
13933-9 BRUSH STREET
Detroit 3, Mich. TO 9-3403

Wholesale Only

CHOPPERS

Stevens-Arnold Type 364; SPDT contacts; coil 18 volts, 10 to 500 cycles; octal plug-in base; regular factory price $42.75. Our price $15.00 each.

Stevens-Arnold Type 365, same as above except coil 28 volts and solder-lug base; Price $15.00 each.

Airpax Type A-580, coil 120 volts, 380 to 420 cycles, price $12.50 each.

Airpax Type A-589-4, coil 6.3 volts, 380 to 420 cycles, price $12.50 each.

Bendix Autosyn, Type AY-2418-5-B, sealed cans, price $18.00 each.

Kearfott Motor, Type R110-2B-B, new, original boxes, price $17.50 each.
Precision Spur-gear speed reducer to fit above motor, price $17.50 each.

Write for detailed information on the following items:

- Kollsmann type 1912-01 True Airspeed Transmitters
- Kel-F and Teflon wire
- Hipersil and Hipernik Cores
- Sigma 5RJ-8000 G Sensitive Relays
- MS, M7, and MRE-50 Miniature Gold Plated Connectors
- Fairchild Type 748 Multigang Precision Potentiometers

G. GREENE
166-04 67th Avenue Flushing 65, New York

AN CONNECTORS

FAST DELIVERY **FROM STOCK** **LOW PRICES**

Let us quote on your requirements.

All comply with government specifications

Wilgreen Industries
99 MURRAY ST., NEW YORK 7, N. Y.
WOrth 4-2490-1-2

Cadmium or olive drab finish.

WHEN IN NEW YORK, DROP IN AND SEE . . .

LARGEST STOCK OF RELAYS IN THE WORLD

IMMEDIATE DELIVERY — PRODUCTION QUANTITIES IN STOCK

WESTON Type 705 SENSITROL

#R561

Stationary contact is a small powerful permanent magnet and movable contact is iron "rider" mounted on pointer which travels over relay scale. Operating torque moves pointer into magnetic field of stationary contact which draws movable contact and holds it firmly. Contacts remain closed until reset. Will operate directly from a photocell or a group of thermocouples. Net weight 14 oz.

Double contact with Solenoid Reset; Sensitivity 7.5 Microamps; Reset coil 6-24 VDC or 24 VAC; Makes contact on increasing or decreasing values; Contacts; "Twintacts", Capacity 100 ma at 110 volts; Nickel plated brass cover; Weston Model 705 Type 6 #R560 .....**18.75; 10 for 170.00**
Same as #R560 but with glass face; Weston Model 705 Type 6 #R561.....**19.75**
10 for 180.00

Single contact (Normally Open), Solenoid Reset; Sensitivity; 10 Microamperes; Reset coil; 6-24 V DC or 24 V AC; Contact: "Twintact", capacity 100 ma at 110 volts; Glass Face; Weston Model 705 Type 4 #R523 .....**17.75 10 for 160.00**
Same as #523 with Brass Cover Weston Model 705 Type 4 #R523N.....**16.75**
10 for 150.00

SS5 STEPPING SWITCHES

Step & Reset

Mfd. by Western Electric Minor Switch 10 steps and off Contacts: #'s R960, 975, 976 Gold plated brass; Bridging Wiper; others non-bridging; Net. Wt. 1 lb.

	Each	Lots of 10
#R960; Single Level; 6 to 12 VDC.	9.50	8.00
#R975; Single Level; 24 to 36 VDC.	10.50	9.00
#R976; Single Level; 48 to 60 VDC.	11.50	10.00
#R977; Two Level; 6 to 12 VDC.	10.50	9.00
#R978; Two Level; 24 to 36 VDC.	11.50	10.00
#R979; Two Level; 48 to 60 VDC.	12.50	11.00

SS6 Mfd. by Western Electric Co.; 22 step; 5 levels; Bridging Wipers; Contacts; Gold plated brass. Interrupter Switch: 1 Break-Make; Net Weight: 2 lb. 2 oz.

"Homing" Type; 180° Wipers; Step in One Direction

	Each	Lots of 10
#R926; 6 to 12 VDC.	13.75	11.50
#R980; 24 to 36 VDC.	14.75	12.50
#R981; 48 to 60 VDC.	15.75	13.50

SS7 Mfd. by Western Electric Co.; 44 step; 2 Levels; Bridging Wipers; Contacts: Gold plated brass; Interrupter Switch: 1 Break-Make; Net Weight 1 lb. 14 oz.

"Homing" Type; 360° Wipers; Step in One Direction

	Each	Lots of 10
#R927; 6 to 12 VDC.	13.75	11.50
#R982; 24 to 36 VDC.	14.75	12.50
#R983; 48 to 60 VDC.	15.75	13.50

CLARE TYPE 20 "Homing" type; Step in one direction; 20 position; 180° wipers, one bridging and remainder non-bridging; Interrupter Switch: 1 break. #R891; 24-36VDC; 3 levels; Clare #SD19. .**12.95 each**

WESTERN ELECTRIC MERCURY CONTACT

Pressure Sealed; Octal Plug Base

D171584; (Equivalent to 275B); SPDT; 1 coil of 4500 ohms plus 24V Heater. Operating current: 8.0 ma. release current: 5.2 ma. Overall length: 3¼", overall diameter: 1-3/16" #R1021.....**6.95 ea.**
10 for 65.00 100 for 625.00

SIGMA SENSITIVE

SIGMA 4F8000S; 1 ma; SPDT (1C); 8000 ohm; #R425 .....**3.95 ea.**
3 for 10.00 10 for 30.00
SIGMA 5F16000S; 0.5 ma; SPDT (1C); 16000 ohm; #R627.....**5.95 ea.**
10 for 50.00 100 for 450.00

HERMETICALLY SEALED

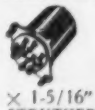
ALLIED SMHX-1; 24-VDC; 6PDT(6C); 10 Amp contacts; 230 ohm; Solder lug header; #271.....**6.50 ea.**
ALLIED SKHXCC; 24 VDC; DPDT(2C) 425 ohm; Solder lug header; #R85...**4.95 ea.**
ALLIED SKHXCCCC; 24 VDC; 4PDT(4C); 425 ohm; Solder lug header; #R86 **5.50 ea.**

A-C RELAYS

ALLIED PO12A115: 115V 50-60 cyc; 4PDT; 10 Amp contacts; #R1025.....**4.50 ea.**
10 for 40.00 100 for 350.00
GUARDIAN 150: 115V, 50-60 cyc; SPDT, 3 Amp contacts; #R1029 **1.50**
10 for 12.50 100 for 110.00

24 VOLT TRANSFORMER; 1.5 Amp; Pri; 115V; 50-60 cyc; Double shielded; Net wt: 1½ lb; #T120 .....**1.50 ea.**
10 for 13.00 100 for 100.00

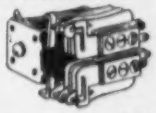
LATEST SUBMINIATURE TYPE



ALLIED 50G MH-12; MIL-R-5757A; 24-29 VDC; 4PDT; 300 ohm; Herm. Sealed; Solder Lug Header; 2.9 oz; Operate time 8 millisec; 1-1/16" dia. × 1-5/16" H; #R1138.....**5.50 ea.**
STRUTHERS DUNN 220XFX100; Same as Allied above but 6PDT; 300 ohm; Herm. Sealed; Solder Lug Header; 3 oz; 1-3/16" dia. × 1-11/16" H; #R1145.....**6.00 ea.**

MINIATURE RELAYS

Automatic Electric Sales, Class S



Twin Code 0, 20 ga Contacts

Volts D. C.	Ohms	Contacts†	Stock No.	Price Each
24	300	3A	R340	1.25
24	640	1C, 1B	R640	1.25
2.5 ma	10000	1C, 1A	R1132	2.00
8 ma	5000	5A	R1133	2.00
24	600	1C	R318	1.15
24	600	2A	R319	1.15
24	600	1A, 1C	R336	1.25
24	600	1A, 1B, 1C	R337	1.35
24	250	4C	R1161	2.75
24	250	6C	R1162	3.25

Clare Type K

24	300	1A	R344	1.00
24	300	2C	R331	1.25
24	300	1C	R345	1.15
3-5	17	1A	R339	1.00
6	30	2C	R1134	1.25
48	1300	2C	R1135	1.50
24	300	1A, 1B, 1C	R1163	1.50
24	250	1B, 2C	R1136	1.50
24	300	.....	R1137	.80

Coil and Frame actuator only (No contacts).

Allied Type TSL

24	300	1A	R346	1.00
24	300	1C	R347	1.00
24	300	2C	R348	1.15
12	150	1A	R338	1.00

Allied Type SK

24	300	1C	R349	1.00
24	300	2C	R67	1.15
24	300	4C	R525	2.25

Allied Type STK

24	300	1A	R350	1.00
24	300	1C	R330	1.00
24	300	2A, 1C	R403	1.25

Allied Type F & Price 1150

6-12	120	1A	R394	1.00
12	100	2A, 1C	R395	1.25
8 ma	3000	1A	R916	1.25

Advance Type 1504 & 1604

24 AC	45	2A	R334	1.00
3	14.5	2C	R650	2.00
12	450	1H	R396	1.50
12	450	2A	R397	1.50

Cook & RBM

24	250	3A	R317	1.25
24	500	2C	R918	1.50
10 ma	6500	4A	R809	2.00
12 ma	5000	1A, 4C	R1164	3.75

Anti-Capacity Types

12-32	500	1A	R106	.90
24	300	1C	R134	1.50
24	300	2C	R351	1.50

Automatic Electric Mfg. Co.

12	200	2C	R921	1.50
6	50	2C	R922	1.50

Miscellaneous Types

Mfgr' & No.	Volts	Ohms	Contacts	Stock No.	Price Each
Kurman	24	1500	1C	R1139	1.00
Leach P3	Series	.09	1C	R1141	.80
Leach P3	6	150	1C	R173	.80
Price TB302	24	300	2A, 1C	R404	1.35

†A=SPST, normally open; B=SPST, normally closed; C=SPDT; H=SPST, double make.

ALL MERCHANDISE IS GUARANTEED AND MAY BE RETURNED FOR FULL CREDIT.

SEND FOR LATEST CIRCULAR. TERMS:—All Prices F.O.B. Our Plant. Rated Firms Net 10 Days; All Others Remittance with Order. Orders Under $10.00 Remittance with Order, Plus Approximate Shiping Charges (Overage Will be Returned).
Cable address: UNIGENCOR, N. Y.

324 CANAL ST., N.Y.C., 13, N.Y. WAlker 5-9642

Universal general corp.

G. E. RECTIFIER

Model 6RC09F16. Input 115v., 60 cy., 1 ph. Output 115v. dc. @ 10 amps. Consists of a metal cabinet 41 x 21 x 21 inches containing a transformer, copper-oxide rectifier, secondary reactor, ventilating fan, control circuits and aux. equipment. Transformer and reactor tapped to vary output. A 0-15 amp DC meter on front of cabinet. A useful piece of equipment for testing in lab or shop where 115 vdc. at 10 amps is needed. Also will charge a 54 cell emergency storage battery. Unused surplus. Only a few of these available. Special....$97.50
Shpg. Wt. approx. 300 lbs.

HIGH POT TRANSFORMER

Westinghouse. PRI: 115, 60 cy. **Sec:** 15,000V C.T., @ .066A, C.T. ungrounded. Excellent for high-potting tests. **Size** OA 12H x 8½W x 9¼D. **Weight** 67 lbs. Fully enclosed steel case. **Price**....$29.50

RADAR ANTENNAS

SO-1 (10CM) assembly with reflector, waveguide nozzle and drive motor. New....$279.50

SO-3 (3CM) Surface Search type with reflector and drive motor, but less plumbing. New in original cases. **$149.50**

SO-13 (10 CM) Complete assembly with 24" dish, dipole, drive motor and gearing. New....$39.50

PLUG IN RELAYS

Clare octal base 75 ohm coil 115 V, 60 Cy. Makes two breaks one. New....$1.95

SCR-522 EQUIPMENT

Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, dynamotor. Brand new equipment with instruction manuals. Write for full details.

1000 Kc. CRYSTALS

TYPE DC-9-AJ. Octal base plug-in type in metal tube holder. As used in BC-221 freq. meter. New. Price....$8.95
TYPE CR-28/U. 200 Kc. mounted crystals. New. Price....$1.65

HIGH-VOLT OIL CAPACITORS

Mfd.	KV	Price
.001	50	$22.95
.02	20	9.75
.025	50	17.95
.025/.025	50	24.50
.1/.1	4.5	3.50
.125	7.5	6.95
.2	50	39.50
.25	15	9.95

SPECIAL
1 MFD. 7500 Volt Pyranol Filled
$6.95

Mfd.	KV	Price
.25	20	$15.95
.25	50	24.50
.5	25	39.50
1.	7.5	6.95
1.	15	29.50
1.	20	42.50
1.	25	49.50
2.	5.5	9.50

BARGAINS IN TEST EQUIPMENT

FLUXMETER. Measures field strength of magnets from 500 to 4000 gauss. Indicates polarity. Probe gap 1¼". British handicraft in fine hardwood case with hinged cover. Operating instructions on underside of cover. Size 12-⅝ x 9 x 6 in. A lab instrument. Also ideal for classroom magnetics instruction. A real buy at only....$14.95

FREQUENCY METER 375 to 725 Mcs. Model TS-127/U. Compact. Self-contained, precision (± 1 Mc). Sturdily constructed Hi-"Q" resonator has average "Q" of 3000. Uses 957, 186 and 384 tubes. Requires standard 1½V "A" and 45V "B" battery, not supplied. Brand new with instruction book, probe and spare kit of tubes....$27.50

TEST OSCILLATOR TS-47/APR, 46-2000+ Mc. Fundamental coverage 40-500 Mc in two ranges. Harmonics above 2000 Mc. Provides a calibrated (dial accuracy ± 0.7 per cent) R.F. source for testing receiving equipment. Output 3MW or more up to 400 Mc. less on harmonics. C.W., mod. pulse or sine wave output. Operates on 115/230 60 Cy. or batteries. Part of A'R countermeasures equipment. New with handibook of Maintenance Instructions....$149.50

300-1600 Mc TRANSMITTER T8S/APTS. Nominal output 10 to 30 watts. Tunable cavity provides range from 300-1600 Mc. Filament transformer operates from 115 V 60 Cy. Uses 8 tubes: 1—931A, 3—6AC7, 2—6AG7, 1—6L6G, 2—829B, 1—3C22 (oscillator). New. Price with 400 cy power supply, plugs, ant., etc....$169.50

INSULATION RESISTANCE TEST SET. Leeds & Northrup portable type. Mfgd. for U. S. Coast Guard Spec. 8-408. Consists of sheet brass covered carrying case 13 x 9 x 14 in. containing telescope, prism, galvanometer, lamp and scale reading device, multiplier shunts, calibrating resistor, cables, etc. New and unused with inst. Special....$75.00

LORAN

APN-9. Complete set consisting of R-65/APN-9 Receiver, PE-206 Inverter, Antenna Coupler, Mounting and Connectors. New. Price....$285.00

APN-4. Complete set consisting of ID-6B/APN4 Indicator, R-9B/APN-4 Receiver, PE-206 Inverter and set of connectors. New. Price....$125.00

MOTOR-GENERATORS

120dc to 120/60/1 @ 2.5kva....$285
115dc to 126/50/1 @ 2.0kva....$185
115dc to 120/60/1 @ 1.88kva....$235
230dc to 120/60/1 @ 1.25kva....$135

MODULATION TRANSF.

For RCA, Type 250-K Broadcast Transmitter (M1-7242) P to P Primary Imp. 15,000 ohms. Secondary Load 5,630 ohms. Size 11¼x9½x13". Wt. 143 lbs. New....$29.50

PARABOLOIDS

46 in. dia. paraboloid. F/D = 0.25. Perforated for low windage. Constructed of stainless steel and aluminum for strength and low weight. Price. $29.50
17½ in. x 4 in. deep. Spun Magnesium dishes. Per pair....$12.50

AMPLIDYNES

5 AM21J37. Input 27 VDC @ 15 A. Output 60 VDC @ 2.5A 4600 RPM. New....$34.50

5AM31NJ9A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 7500 RPM. New....$23.50

INVERTERS

Leland Elec. Co., PE206A. Input: 28DC at 28 Amps. Output, 80V, 800 cy, 1 Ph. 685VA. New....$22.50

G.E. J8169172. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5KVA. New.$32.50

G.E. 5AS1315511A. Model 318J. Input: 28 DC. Output: 115, 400 cy., 1 Ph., 1.5 KVA. Regulated. New....$89.50

G.E. 5D21NJ3A. Input 27 V. D.C. Output 110V., 400 Cy., 1 Ph., 685 VA. New....$29.50

Type PU-7/AP. 2500 VA. Input 28 V. D.C. Output 115 V., 400 Cy., 1 Ph. New....$49.50

DYNAMOTORS

Navy type CAJO-211444. Input: 105 to 130 VDC. Output: either 26 VDC at 20 amps. or 13 VDC at 40 amps. Radio filtered and complete with line switch. New....$89.50

SMALL DC MOTORS

G.E. 5BA50LJ2A. Armature 60 VDC at 8.3 Amps. Field 27.5 VDC at 2.3A RPM 4000. H.P. 0.5. New....$27.50

9 CONDUCTOR CABLE

Army spec. CO-215 Weatherproof 9 Cond. No. 20 AWG stranded tinned copper, plastic ins., color coded, double vinyl jackets with tinned copper braid between. Dia. 9/16" made by G.E. Available 1000, 1500, 2000 ft. reels.
Price $.10 ft. Sample 100 ft. Coil...$10.00

INDICATOR

ID-14/APN-1. 0-4000 ft. Basic range 6.5 ms. Good experimenters item. New $1.79 or 2 for $3.00

G. E. SERVO AMPLIFIERS

Used in B29 planes for Central Station Fire Control Systems. Used to drive Amplidyne 5AM31NJ9A and Control Motor 5BA50LJ2A listed above. New less tubes....$29.50

PHONE DEerfield 7-0044 — **ELECTRONICRAFT** — 27 MILBURN ST. BRONXVILLE 8, N.Y.

KOILED KORDS 3 wires

22 inches long stretches to 9 ft. $1.26

REVERSIBLE GEARED-MOTOR

Delco-PM-Permanent Magnet Alnico Field Motor

#5071805 ¼ SHAFT or 11/18 GEAR....$17.50
#5069600....$18.50
Two Types of Clamps to hold motor: $1.50 ea.

MERCURY SWITCHES
59¢ to $6.00

FILAMENT TRANSFORMER
6v—1½ amps
Weighs—1 lb. 97¢

HG We Buy MERCURY HG

G.E. Switchettes
All types—75¢ ea.
10 for $6.00
100 for $50

115 v. AC RELAY
$2.90

TELECHRON Motors

4 RPM on 50cy or 4½ RPM on 60 cy. $2.85
2 RPM....2.90
3 RPM....3.90
4 RPM....2.90
3.6 RPM.$3.15
1 RPM....3.95
3 R.P. Hr 2.85
1 R.P.2Hr 2.80
1 R.P.12Hr3.25
60 RPM....4.85

Laboratory Special 1 of Each Motor $25.

please include postage

BLAN

EST. 1923

64A Dey Street
New York 7, N. Y.

BLOWERS 115 Volts A.C. 60 cy.

REDMOND 5" 18 watts....$8.95
DELCO 60 cfm. 40 watts. #5062369 used in SB4 RADAR $14.50

HAND WOUND 10 Sec. to 24 Min. TIMER SWITCH..$1.25

6 Watt Most POWERFUL TELECHRON MOTOR 110V 60 CY
1 RPM....$6.50
6 RPM (Reverse.)....$10.00

3" Round Elapsed Time Meter

Square Case $13.75
$14.50

MARKTIME 5 HOUR SWITCH

A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this SPECIAL PRICE....$4.90
Also available in 15 min., or 30 min. or 1 hr. at....$6.50

HAYDON TIMING MOTORS

110v 60 cycle 30 RPM....$2.60
110v 60 cycle 1 RPM....2.60
230v 60cy 1 RPM....1.00
2 RPM....1.00

ELECTRONIC INDUSTRIES

2033 WEST VENICE BLVD. LOS ANGELES 6, CALIFORNIA

Send for free catalogue

Phone: REpublic 5-0215

Cable Address: VHRADELECT

TIME DELAY RELAY

Haydon 115v 60 cy. adj. in 5 sec. steps to 40 sec. spdt mu sw. $3.95. With 2 arms & 2 sw....$9.95
Haydon 5901-2, to 1 min. in .1 min. steps..$7.95

Hundreds of other items, see ad in Buyers Guide Issue, write for listings.

EMPIRE ELECTRONICS COMPANY
409-Q Ave. L. Brooklyn 30, N. Y. Cloverdale 2-4000

ART-13/T47A Transmitters....$175.00	BC-348 Rec'r Modified $ 25.00
ART-13/T47 Transmitters....$125.00	BC-348 Rec'r Unmodified....$ 50.00
BC-788 C Altimeters $175.00	A R C - 1 Transceiver $300.00
A R C - 3 Transceiver Complete....$325.00	BC-342 Rec'r. $ 50.00
RS/ARN-7 Radio Compass....$175.00	BC-312 Rec'r. $ 40.00
	I-132-C Indicator $ 50.00

Ship via Express C.O.D. Subject to Inspection to H. FINNEGAN. 49 Washington Ave. Little Ferry, N.J.

IF THERE IS
Anything you want
that other readers of this paper can supply
OR—
Something you don't want
that other readers can use, advertise it in the
Searchlight Section

CONSISTENTLY . . .

HIGH QUALITY ELECTRON TUBES

AT SENSIBLE PRICES!

GUARANTEED • UNUSED • BOXED • 1st QUALITY • WRITE FOR COMPLETE LIST

AND MANY OTHERS! OVER 1000 TYPES IN STOCK . . . WRITE!

4PR60A (Surp) **$50.00**

450-TH (Surp) **$47.50**

75C-TL (Surp) **$40.00**

We stock complete line of:
BARRY—DIRECTRON
SELENIUM RECTIFIERS
Write for free catalog.

Terms: FOB—NYC—25% Deposit with order—or send full remittance to save COD charges—D & B Rated Firms (F2½ or Better) Net 10 days. CABLE: BARRYLECT, N. Y. TELEGRAPH: BARY ELECTRONICS. FAX. N.Y.C.

TUBE CARTONS • STACKERS

Super gloss red & black or plain glossy white. Both types with new safety partitions that meet U. S. Government specifications. Specify white or colored when ordering.

FOR PRICES AND FREE SAMPLES—WRITE ON YOUR LETTERHEAD

BARRY ELECTRONICS CORP.

Dept. 45
512 Broadway, N. Y. 12, N. Y.
Phone: WAlker 5-7000

SURPLUS INDUSTRIAL **ELECTRONICS** WHOLESALE RETAIL

DUAL RANGE FREQUENCY METER—"Frahm"—48-52; 58-62 CPS. 125 V.—Miniature Type. Brand New, Ind. Boxed ..... EA. 14.95

REED TYPE FREQ. METER, Aero or Biddle—7 Reed—58-62 CPS.—115 V.—Panel Mount—Br. New ..... EA. 11.95

2½" ROUND—0-50 MICROAMP DC—Hermetic Seal. Ruggedized. White Scale—Black Numerals—Current JAN—New ..... EA. 5.95

2½" RD—0-150 VAC—Burlington—Flush Mt. Bakelite—Wht. Scale ..... EA. 2.95

ECHO BOX TEST SET

OBU-3 NEAR NEW **24.95**

CONTACTOR MAIN MONITOR CONTROLLER, consists of Interrupter, Spring Coil; Coil Rating—115 VAC—60 Cycle. Breaker and Controls Rated 15000 Volts—200 Amps. Mfgd By Monitor Control # MP 1179-12. New ..... EA. $10.00

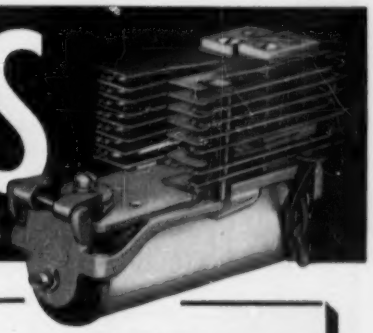
SLOTTED LINE TEST SET, TS-568/AP. Battery operated. 360-675 MC. 51 Ohms New $99.50

TUBE TYPE 1625, Crates of 600 ..... 17¢ each

REX RADIO SUPPLY CO.
88 Cortland St. N. Y. 7, N. Y.
ALL MDSE. FOB N Y

RELAYS

world's largest stock



★ Immediate Delivery
★ Hundreds of Types
★ All Standard Makes
★ New-Inspected-Guaranteed

Mulitple Contact
Standard Telephone Type Relay
CODE 4 TWIN CONTACTS
11-Form A 1-Form B 1-Form C 1-Form D
Heavy duty armature bearing. Available in all standard coil resistances from 12 ohms to 12,000 ohms. Single or quantity prices on request. In stock.

See Our Ad on Page 222

24 HOUR DELIVERY OF THESE TYPES

Standard Telephone Relays
Short Telephone Relays
Midget Relays
Timers
Aircraft Contactors
Rotary Relays
Western Electric Type "E" Relays
Keying Relays
Hermetically Sealed Relays
Voltage Regulators and Cutouts
Differential and Polarized Relays
Special Relays
BK Series
Antenna and Ceramic Relays
Motor and Control Relays
Relay Assemblies
Latching and Interlocking Relays
Mechanical Action Relays
Ratchet and Stepping Relays
Time Delay Relays

Write for New Relay Sales Catalog, C-7

Relay Sales
P. O. Box 186-AA, West Chicago, Ill. Phone West Chicago 1100

FOR SALE

RESISTANCE WIRE on Spools
Insulated NICHROME Sizes
18 to 32—also CUPRON bare
in Sizes 20 to 32 Total Approx. 400#
DUMET Wire on reels Diameter .040 Approx. 200#
DUMET Rod 7-1/16 round, over 5 feet. Totaling Approx. 1,000#

Write or phone

DIAMOND METAL COMPANY, Inc.
70 Pine Street New York 5, N. Y.
Telephone: Whitehall 4-2282

SERVO SPECIALS

60 CYCLE SERVO MOTOR & GENERATOR

Navy Type CAN-211773 — 6.5 watts. Manuf. by Sangamo or Kollsman. Motor input is 115 volts per phase at 60 cycles. 2 pole construction gives speed of approx. 3350 rpm. Tachometer generator is of the constant frequency type with an output of 6.5 volts per 1000 rpm. Output shaft has a 10 tooth helical gear.

SA-513 **$37.50**

TYPE 15CX4A SYNCHRO TRANSMITTER

Designed for BuOrd to meet new specifications for smaller units. Voltage rating 115/90 volts at 400 cycles. Maximum electrical error 12 minutes.. Total weight 0.4 lbs. Dimensions 1.89" x 1.437" diameter. Synchro-type mounting.

SA-465 **$17.50**

TYPE AY101D PRECISION AUTOSYN TRANSMITTER OR CONTROL TRANSFORMER

26 volts, 400 cycle, single phase input. Will operate on 6 volts 60 cycles.

SA-24 **$9.50**

TYPE 1SF SYNCHRO

Manuf. by Bendix & Ford Instrument Co. Although this is a Navy Synchro designed for a 400 cycle excitation of 115 volts, it has been very successfully used on 60 cycle supplies not exceeding 32 volts. Since it has an internal mechanical inertia damper, it can be used either as a "transmitter" or as a "repeater". We strongly recommend this unit for many commercial applications requiring compact remote indicating assemblies.

SA-29 **$9.50**

WRITE FOR COMPLETE CATALOG

Servo-Tek

PRODUCTS CO.

INCORPORATED

1086 Goffle Rd. Hawthorne, N. J.

HAwthorne 7-3100 WUX Hawthorne N J

SEARCHLIGHT Equipment Spotting Service

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used electronic equipment and components *not currently advertised.* (This service is for USER-BUYERS only) No charge or obligation.

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment and/or components wanted on the coupon below, or on your own company letterhead to:

Searchlight Equipment
Spotting Service
c/o ELECTRONICS
330 W. 42nd St., N.Y. 36, N.Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment
Spotting Service
c/o ELECTRONICS
330 W. 42nd St., N. Y. 36, N. Y.

Please help us locate the following equipment, components:

. . . . . .

. . . . . .

. . . . . .

NAME . . . . . TITLE . . . . . .

COMPANY . . . . . .

STREET . . . . . .

CITY . . . . . ZONE . . . . STATE 4/56

TEST EQUIPMENT — RADAR SETS

AN-107A	I-96A	RF-4A/AP	TS-76/APM-3	TS-203/AP
AN/APM-3	I-96B	TAA-16EA	TS-89/AP	TS-207/AP
AN/APR-1	I-108	TBH-3SE	TS-90/AP	TS-222/MPM
AN/APR-2	I-122B	TFX-10GA	TS-91/TPS-1	TS-226/APA
AN/APR-4	I-143	TFX-13GA	TS-92/AP	TS-239C/U
AN/APR-5	I-144	TPS-51PB/10	TS-98/AP	TS-250/U
AN/APT-5	I-148	TS-1/ARR-1	TS-100/AP	TS-251/UP
AN/APT-10	I-178A	TS-2/TG	TS-101/AP	TS-263A/TPS
AN/PSM-2A	I-196B	TS-3A/AP	TS-102/AP	TS-268/U
AN/PSM-6	I-198	TS-6/AP	TS-103/TPM	TS-270B/UP
AN/SPR-1	I-200	TS-8A/U	TS-105/TPM	TS-278/AP
AN/TRM-3	I-203A	TS-10B/APN-1	TS-107/TPM	TS-285/GP
AN/URM-1	I-208	TS-12/AP	TS-108/AP	TS-294/U
AN/URM-23	I-211	TS-13/AP	TS-110/AP	TS-297/U
AN/URM-43	I-223A	TS-15/AP	TS-111/CP	TS-305/AP
AN/URM-67	I-233	TS-16/APN	TS-114/APS	TS-319/URM
AN-USM-24	IE-17E	TS-19/APQ	TS-116/APS	TS-320/URM
AN-USM-45	IE-21A	TS-24/ARR-2	TS-117/AP	TS-322/URM
AN/USM-50	IE-36	TS-26/TSM	TS-125/AP	TS-328A/U
AS-23/AP	IE-56	TS-27/TSM	TS-126/AP	TS-330/TSM
AS-251/AP	LAF-2	TS-32C/TRC	TS-131/AP	TS-338/U
AT-49/APR	LM-13	TS-33/AP	TS-143/CPM	TS-343/U
AT-48/UP	LS-1	TS-34/AP	TS-146/AP	TS-352B/U
BC-221	LW	TS-35/AP	TS-147/AP	TS-358/U
BC-376H	LZ	TS-36/AP	TS-148/UP	TS-363/U
BC-638	ME-73	TS-45/APM	TS-153/AP	TS-382A/U
BC-650A	MK-30A/UP	TS-46/AP	TS-153C/UP	TS-418B/U
BC-905A	MK-33/AP	TS-47/APR	TS-159/TPX	TS-419/U
BC-1060B	ME-6C/U	TS-48/AP	TS-164/AR	TS-419C/U
BC-1066B	ME-9/U	TS-51/APG-4	TS-170/ARN-5	TS-488/U
BC-1096	ME-11/U	TS-53/AP	TS-173/UR	TS-505/U
BC-1148	ME-73	TS-56/AP	TS-174/U	TS-509/UR
BC-1155	MX-306/AP	TS-59/APN	TS-175C/U	TS-537/TSM
BC-1236A	OAV-1	TS-61/AP	TS-184/AP	TS-545/UP
BC-1277	OAO-2	TS-62/AP	TS-186/UP	TS-670/UP
BC-1287	OBU-2	TS-69/AP	TS-189/AP	TS-710/TSM
FR-13/U	OBU-3	TS-70/AP	TS-192/AP	TV-3C/U
I-83F	OS-8/U	TS-74/UPM	TS-197/U	TV-7/U

Many other types available. Allow us to quote on your needs.

AN/APS-3 Mark 16
AN/APS-4 Mark 20
AN/APS-13 SCR-548
AN/APS-15 SCR-882
AN/CPN-6 SCR-717C
AN/CPN-8 SCR-720

Leru Laboratories, Inc. offers the most comprehensive inventory of Radar Sets and Test equipment. **Leru** has the vast laboratory facilities and Engineering talents to certify this equipment to original specifications. **Leru** offers a ten year record as a prime supplier, both at home and abroad of Radar, Communications and Navigation Equipments and their associated Test Sets.

Leru Laboratories, Inc.

827 BLACK OAK RIDGE ROAD — *TErhune 5-2765-6*
Wayne Township, Paterson 2, N. J. — *Cable Address: LERULABS, New Jersey*

NEED METERS?

STANDARD or SPECIALS
ANY QUANTITY — NEW — SURPLUS

FOR ELECTRONIC — MILITARY
AIRCRAFT — HAMS

ALL MAKES — MODELS
RANGES — SIZES

METERS REPAIRED
RESCALED
RECALIBRATED

WRITE - PHONE - WIRE

INSTRUMENT SERVICE

455 B. 67th St.
Arverne, New York
CAA No. 4264 Ltd. NE 4-8594

400-800 CYCLE MOTOR-GENERATOR SETS
& ALTERNATORS
FOR SALE OR FOR RENT
1 to 5 KVA—1 PHASE & 3 PHASE
IMMEDIATE DELIVERY
ALL INQUIRIES INVITED
SEND FOR OUR LIST

EDWARD WOLF COMPANY
P. O. BOX 82 MATTAPAN 26, MASS.
BLuehills 8-1254

AN/APR-4 LABORATORY RECEIVERS

Complete with all five Tuning Units, covering the range 38 to 4,000 Mc; wideband discone and other antennas, wavetraps, mobile accessories, 100 page technical manual, etc. Versatile, accurate, compact—the aristocrat of lab receivers in this range. Write for data sheet and quotations.

We have a large variety of other hard-to-get equipment, including microwave, aircraft, communications, radar; and laboratory electronics of all kinds. Quality standards maintained.

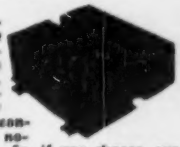
NEW TS-13/AP X-BAND SIGNAL GENERATORS with manual $575.00; T-47A/ART-13 Transmitters, $450.00; H-P, Boonton, G-R, Measurements, many others in stock.

ENGINEERING ASSOCIATES
434 PATTERSON ROAD — DAYTON 9, OHIO

A BARGAIN FOR YOU in a....

SOLA *Constant Voltage* TRANSFORMER

End Fluctuating Line Voltage



OVER 60% OFF . . . the factory price of a 1-input 2,000 VA unit! And here's another bonus! This Air Forces 2,000 VA overstock, Sola Cat. No. 30768, has 4 inputs! 90-125 V., 190-250 V., 60 cy. or 50 cy. isolated secondary is constant 115.0 V. ± 1% from no-load to full-load of 17.4 amp. So, if you choose, use it as a 220:115 V. step-down. And slash $147.50 off the factory 1-input price!

Brand new in original wood box. 4 cu. ft. Ship. wt. 254 lbs. F.O.B. Pasco, Wash. Only **$97.50**

(EXPORTERS: Note choice of 50 cycles.)

THE M. R. COMPANY
P. O. Box 1220-B — Beverly Hills, Calif.

"TAB"

High Current Power Supplies

ONE YEAR GTD

Variable 6 to 28VDC, Completely Built, Ready to go. Full Wave Selenium Rectifier, Transformer, Variac, Volt & Amp Meters, Switch, Terminals & Fuse. Hvy Duty Steel Cabinet Std 115V/60cy Input or 230V 1 ϕ (3 wire) to order.

Stock NUMBER	Continuous Rating	With Meters
T28V6A*	0-28 VDC at 5 Amp	$68
T28V15ACC	15 Amp (5 % Ripple)	88
T28V15AJCE	15 Amp 0.01 % Ripple	146
T28V12A	0-28 VDC at 12 Amp	138
T28V12ACC	12 Amp (5 % Ripple)	160
T28V12AJCC	12 Amp 0.01 % Ripple	220
T28V24A †	0-28 VDC at 24 Amp	188
T28V24ACC †	24 Amp (5 % Ripple)	260
T28V24AJCC †	24 Amp 0.01 % Ripple	318
T28V40A †	0-28 VDC at 40 Amp	288
T28V40ACC †	40 Amp (5 % Ripple)	418
T28V100A	0-28 VDC at 100 Amp	900
T28V100ACC †	100 Amp (5 % Ripple)	1100

Variable 75 to 135 VDC Completely Built, Ready to go. Includes F. W. Selenium Bridge Rectifier & Rectangular Volt & Ammeter. Specify for 115 or 230 VAC 1 phase, 60 cy Input.

T120V15AC	75 to 135 VDC at 5 Amp	$190
T120V15ACC	5 Amp (5 % Ripple)	240
T120V15GAC	75 to 135 VDC at 10 Amp	245
T120V15GACC	10 Amp (5 % Ripple)	395

* Meters: All Others ‡ Meters Extra
POWER SUPPLIES TO YOUR SPECS.
WRITE US YOUR REQUIREMENTS

DC Power Supply

6 or 12V DC Power Supply Full Wave Rectification 6000 MFD Condenser Filter Ready to operate. Input 115V 60cy Output 6.3 or 12.6V

Model 2DCF (2 amp)	$12.98
Model 5DCF (5 amp)	20.94
6DCF ACC/6 amp/1% Ripple	38.98

"TABTRAN" Rectifier Xfmrs

Sec'd Volts (DUAL) 0-9-15-18-18-15-9-0
Series Sec'ds 0-3-6-9-12-15-18-21-24-27-30-33-36 Volts

TR5007	5 Amp‡	$4.98
TR5008	7 Amp‡	6.98
TR5001	1 Amp‡	8.68
TR5002	12 Amp‡	16.58
TR5003	24 Amp‡	25.50
TR5004	50 Amp‡*	48.50
TR5006	100 Amp‡*	107.50

16 Volt 2 Amp $1.98; 2 for $3.50
† Windas in Series at Ratings shown; Parallel 2X Current; Voltage 0-5-10-16.
* Dual Pri 115 & 220V 60cy.

New Variable Voltage X-fmrs

SUPERIOR-GR-STACO-UTC

0-135V-1.25A	$7.23
0-135V/3A	13.95
Cased 0-135V/7.5A	19.65
Uncased/0-135V/7.5A	15.38
Cased 0-270V/3A	16.95
Uncased/0-270V/3A	17.00
Cased/0-135V/15A	39.10
Cased 0-270V/5A	39.10
Uncased 0-270V/7.5A	51.64
Cased 0-270V/9A	81.50
Cased 0-270V/12A	$107.10
Cased 0-270V/18A	124.95
Cased 0-270V/30A	154.70
GR6A/0-135A/1N	135.00

BUY AS YOU NEED AT FACTORY DISCOUNTS
Large Stocks & Immediate Delivery

FILTER CAPACITORS

CE156M	6000MFD 15V	98¢; 2/$1.50; 10/$5
CE502M	2000MFD 50V	$2.50; 10 for $20
CE603M	3000MFD 60V	$3.98; 2 for $7

Heavy Duty Battery "Fast" Charger Rectifier

13-0-13V (CT) 100 Amp Fan Cooled Input 115 VAC Air Cooled. Req'ms 6V 60A and 6V/100A Booster Charges.
Model CR16 $52.60
18-0-18V(CT) Fan Cooled for 12V/ 60A and 6V/100A Booster Charges.
Model CR30 $14.00

NEW "TABTRON" SELENIUM RECTIFIERS

ENGINEERED FOR INDUSTRY

"Technical Apparatus Builders" mfrs. Power Rectifiers to your specs. From one amp up to and above 1000 amps, convection or fan cooled, single or 3 phase. "NEMA" & JAN. Specs. Write for catalog.

* FULL WAVE BRIDGE • DATED & ONE YEAR GTD

Max Amp	28VAC* 14VDC	56VAC* 28VDC	64VAC* 42VDC	72VAC* 56VDC	130VAC* 108VDC	266VAC 217VDC	Ctr Tap AC/DC 30/12	3 Phase 120VAC	Bridge 240VAC 100VDC
1	$1.49	$2.38	$3.76	$4.45	$7.48	$25.00	$2.40	$17.10	$21.25
2	2.00	2.95	5.30	6.85	10.25	29.00	2.70	18.25	25.50
3	2.98	3.98	6.70	8.98	14.98	32.00	3.00	20.00	30.00
4	3.50	6.40	13.25	14.50	25.00	48.00	3.40	21.70	42.45
6	4.95	7.70	16.75	17.75	29.65	52.00	3.70	24.00	48.00
8	6.00	8.95	18.25	20.00	34.25	60.00	4.00	42.40	62.70
10	7.25	14.25	22.60	29.50	43.85	100.00	6.50	48.15	94.20
15	11.00	15.60	37.50	48.00	64.50	151.50	9.15	68.50	132.60
20	13.98	25.00	47.85	64.25	89.65	191.00	15.45	103.25	181.90
30	18.50	28.50	64.25	78.50	108.00	236.00	14.90	135.50	259.80
40	27.85	34.25	86.25	98.00	132.50	296.00	17.50	155.10	310.40
50	29.40	42.00	101.00	118.00	173.00	405.00	27.20	206.85	413.90

"TABTRAN" Rectifier Chokes

CR6001/1 Amp/0.1 HY/1.4 Ohm	$4.98; 2 for $8
CR6002/3 Amp/0.1 HY/.6 Ohm	$6.75; 2 for $11
CR6003/5 Amp/.07 HY/.6 Ohm	$7.98; 2 for $15
CR6004/12 Amp/.01 Hy/.1 Ohm	$14.98; 2 for $28
CR6005/24 Amp/.004 HY/.025 Ohm	$29.98; 2/$58
CR6006/40 Amp/.004 HY/.012 Ohm	$62; 2/$100

New! Quality VOLTAGE REGULATOR ONLY $16.98

Line Voltage Stabilizer

Stabilizes line voltage within 1% or minus 3 % regardless of load. VOLTAGE & FREQ. Shift. Ideal for INDUSTRIAL, LAB or TV & RADIO use. Automatically operated ... regulator turns on & off with set or Equipment. TROUBLE FREE, QUIET, needs no adjustment. Universal Use—from 100 to 800 Watts. Input 100-125V/Output 115V plus or minus 3% 50/60 cycles—.

New Variable 0 to 6 & 12 Volt 12 Amp DC Power Supply

Battery Eliminator Charger Model RR Plater Aircraft Marine or any DC Req. Extra Hvy Duty Selenium Rectifier. 2 Meters V. & A. Dsgnd for Cont. Service and up to 20 Amp instantaneous overload. New Model T6&12V12AC SPECIAL $29.81

230 to 115V Autoformers

For 220V/50cy Input. To 110-120V or Step up. † With Cord, Plug & Receptacle.

TPA500/500W *	$2.55
TPA075/75W †	3.65
TPA100/100W †	4.00
TPA200/200W †	5.50
TPA250/250W †	6.75
TPA500/500W †	8.25
TPA750/750W †	11.70
Model TPA1000 Watts; 1 kw †	16.95
TPA1500/1500W †	$22.50; TPA2000/2KW ... $34

* Less Cord, Plug & Receptacle.

NEW G.E. PHONO CARTRIDGES

RPX050A .001 & .003	$6.75
RPX052A Gold Treasure	19.25
RPX053A Gold Treasure	24.50
RPX049A Single (S) .003	5.68
RPX041A Single (S) .001	5.68

Repic'ment Needles "TETRAD" diamond†

RPJ010A Dual (s) .001 & .003 GE **	$2.20
RPJ012A Dual (D) .001 & .003 Tetrad†	18.18
RPJ013A Dual (DJ) .001 & .003 Tetrad†	18.18

Repic'nts for New A Cartridge Only

RPJ010 or RPJ010 Single (D) Tetrad†	9.96
RPJ016 or RPJ016 Single (D)	3.36

Repic'ment Stylli for RPX040 & 041 Only

RPJ001 or RPJ005 Single (S) GE *****	3.18
RPJ003 or RPJ004 Single (DJ) †	9.85

Complete Stock of Repic'ment Needles
Send Cartridge Name and Number

WRITE FOR OUR NEW
HI-FI CATALOG
$ $ SAVES $ $

"TAB" HI-FI SPEAKERS

Inbuilt network 2 wires needed for HF & LF Response. Famous Hi-Fi mtg. 16" Coaxial PM 2 Speaker System 20-W/20-17500cy Model PJSCO. $19.50
12" Coaxial PM & 2½" Tweeter 12W/ 4" 15000 cy Model PJ2CO $12.75
8" Coaxial PM & 2½" TW 8 Watts 70-18 KC Model PSCO $7.75

HI-FI RECORDING TAPE

Finest, $, $, $, Back Gtd

PRECISION COATED & SLIT Gtd Splice free. Quality Controlled. Plastic Base. Gtd. Constant Output. Freq. 7½ IPS 40-16KC Guide Wnd. In 7" Reel 1200 ft per Reel.

"TAB" SPECIAL @ $1.39 EA; 3 @ $1.30 EA 12 FOR ..... $1.45 EA

SEND US YOUR REQUIREMENTS

"VECTOR" PLUG-IN STANDARD TURRET

CI2M CAN, OCTAL PLUG & 7 PIN TOP SOCKET. Regularly $1.52! "TAB" SPECIAL .39¢; 2 for $1

KLYSTRON "X" BAND

HOUSING. Latest Sealed Coat design for 2K25 or 723AB. Contains locking tube socket, variable frequency control coupler to X band w.g. containing geared variable attenuator. Input front end for generator of Freq. Mtr. Coaxial output. SPECIAL $25

WAVEGUIDE TEE 106A Sperry 2.95-6 Kmc Special $¢ ea. 2 for $12
WAVEGUIDE TEE 107A Sperry 2.95-6 Kmc @ $12 ea
LINE ADAPTER 106 Sperry 2.6-4 Kmc Only $6 ea. 2 for $12
LINE ADAPTER 100A Sperry 5-6 Kmc $12

HEAVY DTY 115v/60cy SATURABLE REACTOR TRANSFORMER

4 wnds, wt 14 lbs, will handle a control line voltage fluctuations up to 600 Watts. WITH DATA ..... $8, 2 for $9

THOR ELECTRIC DRILLS

2013 ¼" Electric Speed Drill w/Jacobs chuck 2400 RPM 115VAC/DC $34.95
4003 ¼" Electric Speed Drill w/Jacobs chuck 650 RPM 115VAC/DC $29.95

MICA CONDENSERS

MFD	WVDC	Price
.03	600	59¢; 100/$50
.01	1200	49¢; 100/$40
.001	1200	39¢; 100/$32
.002	1200	75¢; 100/$25
.012	2500	$1; 100/$60
.002	2500	75¢; 100/$60

"TAB" SPECIAL BARGAIN BUYS

NEW MINIATURE DIEHL PM MOTOR—Type FD6-21, RPM 10,000/27.5VDC Excellent motor for fan cooling @ $2.50; 5/$10—motor & fan ..... $3.50; 4 for $12
MINIATURE HI Q INDUCTOR, 0.5 Hy accy mu metal core ..... $1.25; 6/$5; 12/$9; 24/$16
GIANNI Bellows actuating Precision Potentiometer. Temp comp cost $200 ..... $10 EA; 2 for $18
Same except Sperry 4700SA ..... $10 EA; 2 for $18
FENWAL THERMOSWITCH #17111 Precision adjustable Fluid or Air control—100 to +400°F ..... $3.00 EA; 2 for $5
MICRO-POSITIONER, Rather Colman AYLX5822-8 polarized DC relay. Double coil differential current sens. for remote control ..... $3.98; 2 for $6
2.2 k ohm.
BOURNS MINIATURE PRECISION "TRIMPOT", 2000 Ohms ..... $2 EA; 6 for $10
EDISON TIME DELAY RELAY, Octal Base 28 or 12B Volts ..... .98 EA; 12 for $10
PLANETARY DRIVE: 5:1 & 1 to 1 Ratio $6.29 Reg. Special 32; 3 for $5; 10 for $15
Sondle-Pioneer Autosyn AY-201-2A, Rotor 1 Phase 26V Stator 3 Phase 11.8V/400~ ..... $8; 2 for $15
Sondis-Pioneer Autosyn AY-166-A1, Rotor 1 Phase 115V Stator 3 Phase 18.2V/400~ ..... $8; 2 for $15

WRITE FOR OUR NEW $ BONUS CATALOGS $

FAIRCHILD Precision Potentiometer, Type 736—Five gang, 3 units, 10,000 Ohm, one 25,000 Ohm, one with 2 taps accy = 0.5% 2.5 Watts Servo mtg. $100 Reg ..... $8; 4/$25
TYPE 746—Three gang, two 9.5K Ohm, one 12K Ohm, accy = 0.5 & 1%/2.5 Watt ..... $6 EA; 6 for $25
TYPE 746—Dual 50,000 Ohms, accy = 0.1%/2.5 Watt ..... $4 EA; 3 for $10
TYPE 746—Dual 20,000 Ohms, accy = 0.5%/2.5 Watt ..... $4 EA; 3 for $10
TYPE 746—Dual 8000 Ohms accy = 0.5%/2.5 Watt ..... $4 EA; 3 for $10
RELAY, VACUUM SEALED, CLARE SK5018/DPDT/18-28VDC/2 Amp CTR Octal Base ..... Special Buy @ $2.50 EA; 5 for $10
DELAY LINE—ESC #2200/0.4 mu sec/ds ..... $1.50 EA; 6 for $7
FILTER L-5, Range or Value Filters 1000 cycle audio excellent for CW ..... Only 39¢; 2/$1
SINE/COSINE LINEAR SAWTOOTH DC Precision Line Potentiometer FK5152J8, 100 Ohm—$100 Reg ..... Buy @ 89¢; 6 for $5
FULL WAVE SELENIUM RECTIFIER, 35 ma/115VDC rated ..... @ 10¢; 10/$1.40
New Radio-TV 130V/65MA Rectifiers, 6/.50¢, 25/.45¢, 100/.41¢ ea.
STEVENS ARNOLD DC-AC CHOPPER, 0-500CPS Type CH165 SPDT Coil DC 26V/800Ω, imp 60 cyc/830 ohm, 400 cyc/1100 ohms. Electro-Mech Vibrator used as chopper, rectifier, demodulator, sq wave generator. Excellent SERVO APPLICATIONS. Reg. $20 @ "TAB" SPECIAL $3. 4 for $10

NEW SHAWLITE ELECTRONIC Flash Kit 400 II

Uses new lo cost, lo voltage SUPER CIRCUIT constant bright light output 60 36 watt sec'ds; light duration 1/600 sec'd; color Kelvin 6800°; guide # Exposure 75 +; B&W 225 +. Cost per flash less than ¾ ¢. 1000 to 2000 flashes per set of 12/240V1 batteries. Recycles 2 sec'ds. Parabola reflector. All parts, instructions, assembled gun, less Batteries. Camera uses 6% " H. 4" W. 2¾" D. Portable unit, wgt 2¾ lbs.

PARTS GTD ONE Year Model 400II	$24.95
"TABLITE" 400V ... AC & Battery, 60 Watt Second	$29.95
SHAWLITE 600L ... 120 Watt Second	$44.95
Battery OPeration	$36.95
"TABLITE" 600V ... AC & Battery, 120 Watt Second	$54.95
"TABLITE" 1000V ... 240 Watt Second AC & Battery	$84.95
Set of Two 240V Batteries	$19.95
KITS ASSEMBLED, Additional	$10
Write For Complete Data & Specifications	
FLASH LAMP GUN, Holder & 10" Wire Range Reflector, @ $3.49 ... With DX Flash Lamp	@ $13.49
ProFlashlash Cond-525MFD/450V/53W Sec'd. New low leakage. Famous mfgr. @ $8; 2/$15	

PHOTOFLASH & STROBE LAMPS

"TAB" No.	Replaces	W-Sec Mnt	Each
TW1	PA 104/F118	40	$0.98
TH1	Amglo 5804X	100	10.98
22ST	GE FT 210	200	9.95
TWVA	GE LV, 6320	200	9.98
V424	X400	300	10.98
TLX	DX & PA100	180	9.00
TDX	DXC/250-260	250	10.00
253GTQ	FT 503	2000	40.98

TRIGGER COIL LO VOLT FLASH $1.47
COND-525 MFD/400VDC/53 Watt sec'ds NEW low leakage famous mfgr. $8; 2/$15; 6/$39
Send 50c for "TAB" PhotoFlash Data

TRANSFORMERS

ALL 115V 60 CYC INPUT

2500V/20MA, 6.3V/6A, 2.5V/1.75A 4/DC413 Scope Replmnt $7.98
900V/35MA, 2X2.5V/3A, 1800V DBLR TWO 2X2 PIL WNDGS $1.98
270VCT/200MA, 5V/3A 6.3VCT/5A THORDARSON ..... $4.98; 2 for $9; 6 for $24
270V/2.5 MA, 2.5V/3A. HVINS MMELD Includes FILTER PARTS 6/acope $3.49; 2 for $6.00
550VCT/250MA, 5V/2A 6.3VCT/2.5A 115CV SACRO RCA. ..... $4.98; 2 for $8.50
XFMR, Dbl Shell Universal mtg Elctstic Shld. Pri 115V Sond 620VCT/250 ma, 5V/3A, 6.3V/10A @ $5.50; 2 for $10 Sond 550-250 ma
NEW FILAMENT XFMR, 115 Volt Pri/Sec'd 6.3V/350 ma, Cased ..... 89¢; 10/$8

INFRARED SNOOPERSCOPE

SEE IN DARK TUBE

Selected, GTD Image-Converter Tube Bi-Sensitivity simplified desgn 2" dia. Willemite screen. Resolution 40 lin/in. Tube & Data "TAB" Special ..... $5.90; 2/$7.50
Snooperscope Pwr Supply 4500VDC/35MA. Using Dual Doubler Crkt. Transformer, Rectifiers Rockets, Resistors, Capacitors and Diagram 115V/60cy Oper $12.50

PRECISION RESISTORS

1% ACCURACY GTD

Special .1% Ea. 10¢ ea.
10 of One Value $0.90
100 of One Value 8.00
10 Asst'd Values 1.00

HI-MEG HI-VOLT RESISTORS

1 MEG 6W/10KV	89¢ 12 for $9.0
1 MEG "MVP" 10W/16KV	1.00 12 for $10.0
2 MEG 10W/16KV	1.00 12 for $16.0
20 MEG "MVP" 10W/30KV	$2.00 12 for $20.00
50 MEG "MVP" 25W/40KV	$2.50 12 for $25.00
10 MEG "MVP" 10W/10KV	$2.00 12 for $20.00

Lots Fifty 20% Disc.; Lots 100 Disc. 40%

TUBES

"TAB" TESTED INSPECTED GUARANTEED!!!

OA2	$ .74	3C45	7.00	294A	1.95	1201	.75	5819	33.00
OA3	.74	3D21A	2.75	417A	2.75	1620	1.25	5820	49.00
OB2	.64	3D21	5.00	446A	.69	1613	1.00	5829	.99
OB1/VR90	.64	3K21	125.00	446B	1.05	1616	.49	5841	7.98
OC2/VR105	.74	3X2500A	80.00	707B	65.00	1619	.49	5842	13.50
OD3/VR150	.65	4-65A	16.50	712A	1.35	1620	1.00	5844	.85
1AD4	1.24	4-125A	19.99	811DX	1.89	1625	.10	5851	3.50
1AG4	1.24	4B27	6.00	816AX	1.53	1626	.15	5881	1.75
1AX2	1.25	4B27	2.50	816DX	.90	1629	.10	5881	2.79
1B3	.65	4C35	15.00	839DX	2.98	1632	.63	5910	.43
1B22	1.25	4J52	50.00	844DX	2.50	1633	.98	5932	3.95
1B24	4.94	4X150A	22.25	871AX	4.45	1642	.98	5965	1.50
1B26	4.94	5AP1	49.50	872A	1.25	1647	.98	6005	1.50
1B35	1.49	5D21	7.45	HY615	.46	1680	2.00	6082	4.50
1B46	1.98	5U4G	.45	703A	1.70	1850A	65.00	6099	1.55
1B46A	23.50	5Y3	.45	704A	.74	2050	.98	6146	2.45
1D21	1.49	6AN5	2.61	705A	.74	2050W	2.48	6159	45.00
1LN5	.78	6A56	1.20	707B	1.95	2051	.68	7193	.25
1N21	150.00	6A67G	1.25	710A	3.85	5114	4.60	7895	1.25
1X2A	.60	6BQ6	.90	715A	3.85	5516	9.51	8008	2.50
2C22	.25	6J6	.45	717A	.29	5517	2.10	8012	1.89
2C26	.20	6SN7	.55	721A	72.00	5651	1.40	8013	2.70
2C39A	7.95	6X4	.40	723AB	8.00	5654	1.25	8020	2.95
2C43	7.27	6Y6	79.00	724A	.84	5656	2.00	8025A	2.00
2C43	6.50	12AUT	.50	724B	.80	5663	1.06	8001	.90
2C51	2.85	12AX7	.55	725A	2.98	5670	2.24	9002	.57
2D21	1.49	12BY7	2.76	725A	4.20	5672	1.55	9003	1.25
2E22	1.89	19BG6	1.10	801A	.42	5686	2.99	9006	.15
2E26	5.25	24G	2.70	807	1.15	5687	3.59	10P1A	5.95
2E32	.99	NR24	2.70	807W	4.98	5691	4.65	5CP1B1	5.98
2G21	1.95	RK120	.49	814	2.48	5692	5.00	1DP1	2.75
2J32	49.00	WN34	.24	815	1.50	5693	4.75	1KP1A	4.50
2J42	59.00	15Z5	.45	826	1.70	5694	3.70	1EP1	2.40
2K22	14.00	TZ40	1.31	829B	6.49	5697	3.70	1FP7	1.91
2K25	14.00	1X2A	1.35	832A	5.00	5702	2.50	1FP7A	1.95
2K25	25.00	HY65	5.49	836	1.49	5704	2.25	1GP1	1.91
2K29	25.50	QK135	250.00	837	1.95	5718	3.00	5BP1	1.95
2K29	85.00	QK262	250.00	864	.24	5719	3.50	5CP1A	5.95
2K33	100.00	201A	3.50	866A	1.25	5727	1.77	5HP1	3.95
2K39	100.00	215	10.35	872A	1.29	5732	2.85	5JP1	14.95
2K41	90.00	231A	2.52	874	.69	5744	1.88	5JP2	5.98
2K42	125.00	250N	10.95	884	1.38	5749	1.49	5LP1	7.00
2K43	110.00	250TH	15.00	885	1.15	5750	1.45	5KP7	89.50
2K48	80.00	304TH	15.00	927	.90	5751	1.45	10P14A	7.98
2K50	125.00	304TL	15.00	954	.16	5763	4.25	7EP7	4.68
2K51	85.00	311A	.48	956	.16	5783	4.25		
3D24W	5.00	345A	5.00	956	.29	5794	5.50	WRIL—FOR FULL LIST	
3C22	75.00	371B	.90	957	.14	5812	1.49		
3C24	1.50	388A	1.15	1005	.38	5814	.79		

THAT'S A BUY "TAB" THAT'S A BUY
Dept. 4E6 111 Liberty St., New York 6, N. Y., U. S. A. PH. RECTOR 2-0245 CABLE "TABPARTS"

Money Back Guarantee (Cost of Mdse. Only) $5 Min. Order FOB N. Y. C. Add shpg. charges or 25% Dep. Prices Subject to Change Without Notice.

Daven Company ..... 3rd Cover

INDEX TO ADVERTISERS

Ace Electronics Associates 422
Acme Wire Co. 402
Acromark Co. 427
Adams & Westlake Co. 40
Adel Precision Products, A Div. of General Metals Corp. 443
Advance Electronics Lab., Inc. 506
Aeronautical Communications Equipment, Inc. 98
Aerovox Corp. 386, 387
Aircraft-Marine Products, Inc. 36, 37, 273
Air Express Division Railway Express Agency 215
Airpax Products Co. 112, 379
Alden Products Co. 28
Alford Mfg. Co., Inc. 326
Allen-Bradley Co. 118
Allegheny Ludlum Steel Corp. 58
Allied Control Co., Inc. 82, 83
Alloy Precision Castings Co. 370
American Gas Furnace Co. 419
American Lava Corporation 95
American Machine & Foundry Co. 74
American Phenolic Corp. 194
American Television & Radio Co. 232
American Time Products, Inc. 114
Amperex Electronic Corp. 259
Amperite Co., Inc. 278
Andrew Corp. 209
Antara Chemicals, a Sales Div. of General Aniline & Film Corp. 205
Anti-Corrosive Metal Products Co., Inc. 372
Armco Steel Corp. 102
Arnold Engineering Co. 13
Artos Engineering Co. 266
Art Wire & Stamping Co. 432
Assembly Products, Inc. 415
Associated Commodity Corp. 446
Automatic Metal Products Corp. 441
Autonetics, A Div. of North American Aviation, Inc. 369

Bakelite Co., A Div. of Union Carbide & Carbon Corp. 227
Baker & Company, Inc. 422, 442
Ballantine Laboratories, Inc. 220
Barber-Colman Co. 425
Barry Controls, Inc. 21
Bausch & Lomb Optical Co. 437
Bead Chain Mfg. Co. 362
Belden Manufacturing Co. 339
Bell Telephone Laboratories 223
Bendix Aviation Corporation, Eclipse-Pioneer Div. 328
Red Bank Div. 253
Bentley, Harris Mfg. Co. 32
Berkeley Division, Beckman Instruments, Inc. 38
Bird & Co., Inc., Richard H. 440
Bird Electronics Corp. 360
Bliley Electric Co. 250
Boehme, Inc., H. O. 415
Boesch Mfg. Co., Inc. 444
Boonton Radio Corp. 309
Borg Corporation, George W. 384
Brailsford & Co., Inc. 374
Bristol Co., The 340
Brush Electronics Company 391
Burroughs Corp. Electronic Instruments Div. 307
Bussmann Mfg. Co. 70

C B S Hytron, A Division of Columbia Broadcasting System, Inc. 92
Cambridge Thermionic Corp. 44
Cannon Electric Co. 420
Canoga Corp. 388
Carboloy, Dept. of General Electric Co. 241
Carborundum Company, Globar Division 361
Celco-Constantine Engineering Laboratories Co. 290
Centralab, Div. of Globe-Union Inc. 407
Chase Brass & Copper Co. 285
Chatham Electronics, Div. of Gera Corp. 221
Chicago Standard Transformer Corp. 322
Chicago Telephone Supply Corp. 63
Cinch Mfg. Corp. 185
Circuit Instruments, Inc. 358
Clare & Co., C. P. 107
Cleveland Container Co. 202
Clevite Transistor Products 77
Clifton Precision Products Co., Inc. 304
Clarostat Mfg. Co., Inc. 323
Clough-Brengle Co. 504
Coast Coil Company 419
Cohn Corp., Sigmund 427
Coils-Electronics Co. 431
Collectron Corporation 425
Color Television, Inc. 443
Communications Measurements Laboratory, Inc. 388
Computer Measurements Corp. 272
Conrad, Inc. 506
Consolidated Electrodynamics Corp. 330
Consolidated Vacuum, Div. of Consolidated Electrodynamics Corp. 401
Continental-Diamond Fibre, Div. of the Budd Company, Inc. 375
Continental Wire Corp. 290
Cornell-Dubilier Electric Corp. 30
Corning Glass Works 100
Cosmic Condenser Co. 423
Coto-Coil, Inc. 406
Cramer Co., Inc. R. W. 103
Crane Packing Co. 383
Cross Co., H. 419
Crucible Steel Co. of America 297
Cubic Corp. 331
Curtiss-Wright Corp. 324, 438

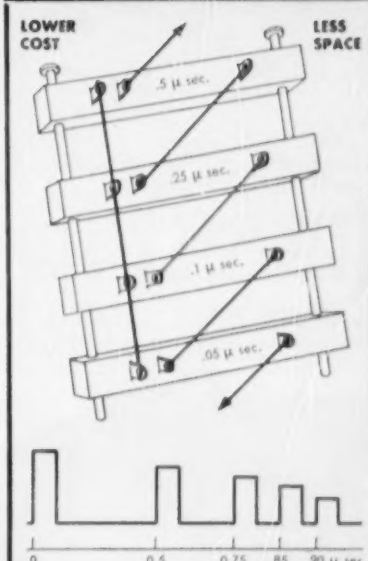
Dale Products, Inc. 276
Dano Products Co. 429

ESSEX

A New Idea

STACKED DELAY LINES

MILITARY – COMMERCIAL



Your special delay line needs can be met by assembling standard units for laboratory or production requirements.

WRITE FOR DATA SHEET

ESSEX ELECTRONICS

Berkeley Heights
New Jersey
CRestview 3-9300

7303 Atoll Ave.
No. Hollywood Calif.

Trenton, Ontario
Canada

Want more information? Use post card on last page.

General Radio Co. 17

DOMESTIC TEFLON* SHAPES

the pioneer is the leader

PANORAMIC *has the instrument you need for analysis and measurement problems*

Get accurate answers fast with Panoramic's Spectrum Analyzers covering the sub-audio thru microwave range, Sweep Generators for sonic and ultrasonic range and Frequency Calibrators.

Send for Panoramic Catalog Digest today and find out how Panoramic can solve your problems.

PANORAMIC
RADIO PRODUCTS, INC.

Makers of
- Panadaptor
- Panalyzor
- Panoramic Sonic Analyzer
- Panoramic Ultrasonic Analyzer and many others

A Partial List of Users of Panoramic Equipment:
Convair
Hotpoint Company
Lockheed Aircraft Corp.
Massachusetts Institute of Technology
Philco Corp.
Radio Corporation of America
Sperry-Gyroscope Co.
U. S. Testing Co., Inc.
Westinghouse Electric Corp
Allis-Chalmers Mfg. Co.
U. S. Atomic Energy Commission
Bell Aircraft Corporation
Bell Telephone Company
Boeing Airplane Company
Cornell University
California Institute of Technology
E. I. duPont de Nemours & Co.
Eastman Kodak Co.
General Motors Corp.
Ford Motor Co.
Chrysler Corp.
Department of Defense
Pratt & Whitney Aircraft
Curtiss Wright
Western Electric
General Electric Co.

80 So. Second Ave., Mount Vernon, N. Y. MOunt Vernon 4-3970
Cables: Panoramic, Mount Vernon, N. Y. State

electronic instruments by **CLOUGH-BRENGLE**

Extended Range Audio Oscillator

Model 420 is a resistance-capacity tuned type oscillator with balanced 135 ohm and balanced 600 ohm outputs from 20 cycles to 250 KC and single ended output from 20 cycles to one megacycle. Output is 100 milliwatts. Distortion is less than 1% from 100 cycles to 100 KC.

• *SEND FOR CATALOG 54A* •

Manufacturers of:

I.F. Sweep Generators • Beat Frequency Oscillators • Audiomatic Generators • Band Spread Audio Oscillators • Extended Range Audio Oscillators • Transmission Measuring Sets • Standard R.F. Signal Generators • Capacity-Resistance-Inductance Bridges • Coil Checkers and Other Associated Equipment.

• REPRESENTATIVES IN PRINCIPAL CITIES •

CB **THE CLOUGH-BRENGLE CO.**

6014 Broadway, Chicago 40, Illinois

Daven Company ..... 3rd Cover
DeJur-Amsco Corporation, Electronics Sales Div. 312
Delco Radio Div. of General Motors 389
DeMornay-Bonardi 303
Dialight Corporation 442
Dit-Mco, Inc. Electronics Div. 274
Donner Scientific Co. 300
Douglas Aircraft Co., Inc. 251
Driver-Harris Co. 257
Dumont Laboratories, Inc., Allen B. 197
Dunlee Corp. 230
DuPont de Nemours & Co. (Inc.), E. I. Film Dept. 305
Polychemicals Dept. 97
Durant Mfg. Co. 390

Eastern Industries, Inc. 201
Eastman Kodak Company 203
Edison, Inc., Thomas A. 374
Elsler Engineering Co., Inc. 416
Eitel-McCullough, Inc. 111
Elco Corp. 429
Electra Mfg. Co. 336
Electrical Industries Div. of Amperex Electronic Corp. 289
Electrocraft, Div. of Hamilton-Pax, Inc. 423
Electro Tec Corp. 271
Electronic Engineering Company of California 415
Electronics Buyers' Guide 319
Electronic Instrument Co., Inc. (EICO) 418
Elgin National Watch Co. Electronics Div. 314
Emerson & Cuming, Inc. 298
Engineering Co., The 408
Epsco, Inc. 235
Eraser Co., Inc. 431
Erie Electronics Division, Erie Resistor Corp. 212
Essex Electronics 503

F-R Machine Works, Inc. 211
Fairchild Camera & Instrument Corp. 286
Fairchild Controls Corp., Components Div. 213
Farley & Loetscher Mfg. Co. 296
Farnsworth Electronics Co. 256
Federal Telephone & Radio Co. 231
Ferroxcube Corp. of America 413
Film Capacitors, Inc. 332
Filtors, Inc. 426
Fisher Radio Sales Co., Inc. 370
Frenchtown Porcelain Company 396

G-M Laboratories, Inc. 76
Gabriel Electronics Div. of Gabriel Co. 287
Gamewell Co. 439
Gates Radio Co. 261
Gee-Lar Manufacturing Company 413
General Electric Company
Apparatus Dept. ..30, 31, 52, 321, 331, 367
Components Dept. 65
Electronics Dept. 117
Laminated and Insulating Products Dept. 41
Tube Dept. 23, 108, 109

NEW MINIATURE CONTINUOUSLY VARIABLE

Kester Solder Co. 225

General Radio Co. 17
Good-All Electric Mfg. Co. 381
Grant Pulley & Hardware Corp. 84
Gries Reproducer Corp. 429
Guardian Electric Mfg. Co. 253
Gudeman Company 414, 415

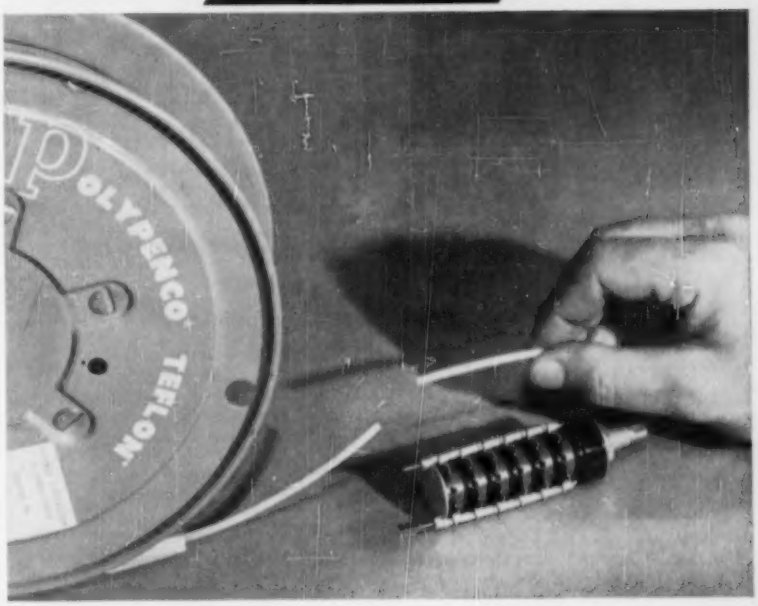
Hall-Scott Electronics 335
Hammarlund Mfg. Co., Inc. 25
Harper Co., H. M. 247
Hart Mfg. Co. 268
Harvey Hubbell, Inc. 267
Haydon Manufacturing Co., Inc. 214
Haydu Brothers of New Jersey 265
Heath Co. 398
Helland, a Div. of Minneapolis-Honeywell 86
Helipot Corp., Div. of Beckman Instruments, Inc. 191
Hermetic Seal Company 249
Hetherington, Inc. 288
Hewlett-Packard Co. 45, 46, 47, 54, 55
Hitemp Wires, Inc. 404
Homelite, A Div. of Textron American, Inc. 316
Houghton Laboratories, Inc. 364
Hoyt Electrical Instruments 424
Hughes Aircraft Co. 87, 311
Hughes Research & Development Laboratories 86, 310
Hunt Company, Phillip A. 338
Hycon Eastern, Inc. 263
Hycon Electronics, Inc. 280
Hycor, Division of International Resistance Co. 400

Illinois Condenser Co. 396
Indiana Steel Products Co. 351
Industrial Development Committee of 100, Lakeland, Florida 431
Industrial Test Equipment Co. 428
Industrial Timer Corp. 340
International Business Machines 359
International Rectifier Corp. 301
International Resistance Co. 104, 105
Irvington Division Minnesota Mining and Mfg. Co. 420

J-V-M Engineering Co. 360
Jet Propulsion Laboratory 277
Johnson Company, E. F. 302
Jones Div., Howard B., Cinch Mfg. Co. ... 427

Kahle Engineering Co. 15
Kay Electric Co. 27
Kearfott Company, Inc. 260
Kellogg Company, M. W. 91
Kepco Laboratories 189

POLYPENCO® TEFLON® SHAPES



POLYPENCO Spaghetti Tubing Proves Resistance To Heat, Simplifies Assembly

One of the newest applications for POLYPENCO Teflon Spaghetti Tubing is its use on a series of miniature rotary tap switches. The choice of this tubing was based on its complete resistance to soldering heats.

These other valuable characteristics make Polypenco Teflon Spaghetti Tubing the ideal choice for your thin wall insulation applications:

- **SUPERIOR FOR COMPONENT PRODUCTION**
  Excellent dielectric permits miniaturization
  Does not break down by bending or flexing
- **SUPERIOR ELECTRICAL PROPERTIES**
  High dielectric strength: 750 v/mil upwards
  Low dielectric constant: 2.0
  High surface resistivity: above 10^{12} ohms
  Services entire frequency range
  Unaffected by heat and moisture
- **SUPERIOR PHYSICAL PROPERTIES**
  Service range: —320°F to 550°F
  High vibration and flex life
- **SUPERIOR CHEMICAL PROPERTIES**
  Resistant to solvents, alkalis, acids
  Zero water absorption
  Fungus resistant
  Non-flammable, sunlight resistant

Polypenco Teflon Spaghetti Tubing is available in 10 coded colors and in AWG wire sizes #8 through #26.

Polypenco Teflon is also available in rod, tubular bar, tape and slab. Write today for more data on your applications.

THE POLYMER CORPORATION OF PENNA. • Reading, Penna.
In Canada: Polypenco, Inc., 2052 St. Catherine St., W., Montreal, P. Q.

POLYPENCO® Nylon, Teflon*, Q-200.5 and K-51

*DU PONT TRADEMARK

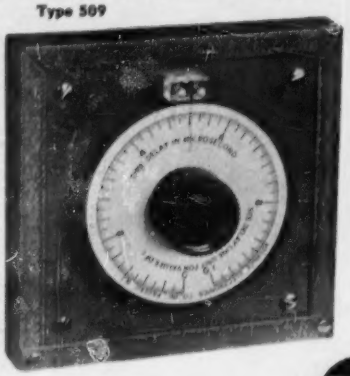
National Lead Co. 62

NEW

MINIATURE CONTINUOUSLY VARIABLE DELAY LINES

Incremental Time Delay Less than $8x10^{-11}$ Sec.

Type 509



- Rise Time less than 8% of the Time Delay at any point.
- Maximum Voltage 500 Volts-Peak
- Useful Bandwidth over 10 MC
- 0-1 us Time Delay
- 400 Ohms Impedance

Many other types available with Time Delay ranging from .05 us to 1.2 us and impedance ranging from 180 Ohms to 580 Ohms.

STEP VARIABLE DELAY LINE TYPE 602

Equal input and output impedance. 11 different steps. Impedance ranging from 75 ohms to 200 ohms. Time Delay 2.75 us in steps of .25 us.

HIGH Z MINIATURE DELAY LINES

Impedance ranging from 1500 ohms to 4000 ohms. Time Delay from 0.1 us to 1 us. Physical size ¼" dia. and less than 6" long. Price $7.50 each, F.O.B., Passaic, N. J.

CUSTOM BUILT DELAY LINES, EITHER FIXED OR VARIABLE

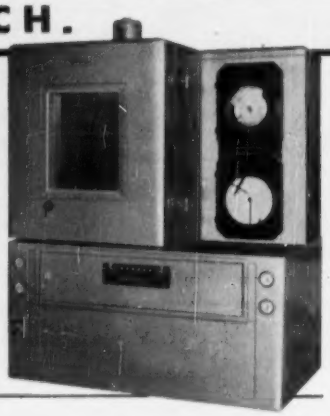
ADVANCE ELECTRONICS LAB., INC.

451 HIGHLAND AVENUE, PASSAIC, N. J.

CONRAD, Inc.

HOLLAND, MICH.

TEMPERATURE AND HUMIDITY CHAMBERS



Meets MIL Specs for Temperature and Humidity cycles with full programming including MIL-E-5272-A

"F" Series — Front Opening
Range: −100° F. to +300° F.
Humidity: 10 % to 97 %
Controllable above at 35° F. D. P.

ALTITUDE AND TEMPERATURE CABINETS

Range: −125° F. to +500° F.
Altitude: Up to 125,000 ft.

TEMPERATURE CABINETS

Range: −150° F. to +500° F.

4, 8, 12, and 27 cu. ft. Standard Models Available — Immediate delivery

Write for File Folder

CONRAD Inc. SUBSIDIARY OF CRAMPTON MFG. CO.

141 JEFFERSON ST., HOLLAND, MICH.

MEMBER OF ENVIRONMENTAL EQUIPMENT INSTITUTE

Kester Solder Co. 225
Kinney Mfg. Div., The New York Air Brake Co. 85
Kleiner Metal Specialties, Inc. 354
Knights Co., James 356
Krohn-Hite Instrument Co. 440

Lampkin Laboratories, Inc. 421
Lapp Insulator Co., Inc. 216
L E L Inc. 427
Leach Corp. 51
Librascope, Inc. 43
Linde Air Products Company, Div. of Union Carbide & Carbon Corp. 444
Link Aviation, Inc. 308
Lockheed Missile Systems Div. 295
Los Alamos Scientific Laboratory of the University of California 282

M. I. T. Lincoln Laboratory 242
MacDonald, Inc., Samuel K. 446
MacLean Corp. 446
Magnatran, Inc. 430
Magnecord, Inc. 441
Magnecraft Electric Co. 423
Magnetic Amplifiers, Inc. 244
Magnetic Research Corp. 332
Magnetics, Inc. 195
Maico Tool & Manufacturing Co. 418
Mallory and Co., Inc., P. R. 130, 187
Manson Laboratories 318
Manufacturers' Representatives 446
Marconi Instruments, Ltd. 283
Marion Electrical Instrument Co. 230, 396
Markem Machine Co. 428
Martin Company, Glenn L. 218, 315
Maxson Instruments 421
McColpinChristie Corp. 429
Measurements Corp. 198
Metals & Controls Corp., General Plate Div. 66
Metal Textile Corp. 346
Micro Switch, a Div. of Minneapolis-Honeywell Regulator Co. 279
Microwave Associates, Inc. 403
Midland Mfg. Co., Inc. 245
Milford Rivet & Machine Co. 400
Millen Mfg. Co., Inc., James 228
Minneapolis-Honeywell Regulator Co. Industrial Div. 377
Minnesota Mining & Mfg. Co. 219
Moloney Electric Co. 64
Muirhead & Co., Ltd. 5
Mullard Overseas, Ltd. 50
Mycalex Corp. of America 233

N J E Corporation 119
National Aircraft Corp. Marvelco Electronics Div. 238, 289
National Fabricated Products Div. of Hoffman Electronics Corp. 275

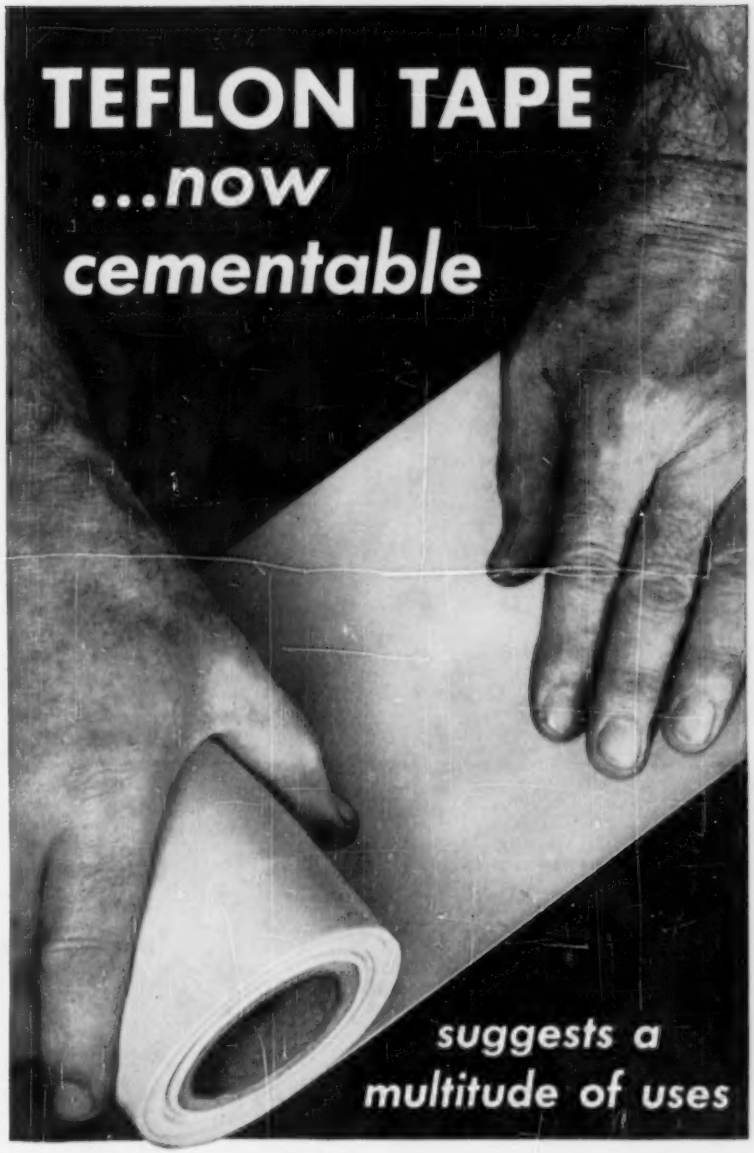
Rheem Mfg. Co. 281
Ucinite Co., The 106

National Lead Co. 62
National Moldite Co. 89
Nems-Clarke, Inc. 362
New Hermes Engraving Machine Corp. .. 421
Non-Linear Systems, Inc. 329
Norden-Ketay Corp. 202, 293
Nothelfer Winding Labs, Inc. 200

Offner Electronics, Inc. 237
Oregon Electronics 399
Orradio Industries, Inc. 240
Otis Elevator Company, Electronics Div. . 49

Pacific Semiconductors, Inc. 199
Panoramic Radio Products, Inc. 504
Penta Laboratories 402
Perkin Engineering Corp. 33
Peter Partition Corp. 431
Phalo Plastics Corp. 258
Phaostron Instrument & Electronic Company 366
Phelps-Dodge Copper Products Corp., Inca Mfg. Div. 56, 57
Philamon Laboratories, Inc. 53
Philco Corp. 71
Phillips Process Co., Inc. 410
Photographic Products, Inc. 444
Pittsburgh Lectrodryer Company McGraw Electric Company Division ... 90
Polarad Electronics Corporation 67
Polymer Corp. of Penna. 505
Poly Scientific Corp. 419
Polytechnic Research & Development Co., Inc. 385
Potter Co., The 348
Potter & Brumfield, Subsidiary of American Machine & Foundry Co. 196
Potter Instrument Co., Inc. 382
Precision Apparatus Co., Inc. 508
Precision Paper Tube Co. 306
Pressman Associates 425
Presto Recording Corp. 410

R B M Division, Essex Wire Corp. 371
Radiation, Inc. 425
Radio Condenser Co. 94
Radio Corporation of America..357, 4th Cover
Radio Engineering Laboratories, Inc. 59
Radio Engineering Products 406
Radio Frequency Laboratories, Inc. 93
Radio Materials Corp. 243
Radio Receptor Company, Inc. 42
Ramo Wooldridge Corp. 343
Remington Rand Univac, Div. of Sperry Rand Corp. 72, 73
Raytheon Mfg. Co. 18, 19, 29, 35
Reeves Instrument Corp. 113
Relay Sales 222
Reliance Mica Co., Inc. 416
Revere Corp. of America 234
Rex Rheostat Co. 446



■ Now, "the material that sticks to nothing" can be cemented to anything (metal, glass, wood, plastics, etc.) with ordinary commercial adhesives (including the pressure-sensitive). Pull test approximately 45 lbs.

This new, treated tape (down to 5 mil. thickness) offers the opportunity for inexpensive, thin-section applications of this material for many services where *TEFLON's unusual dielectric properties, zero water absorption, broad service temperature range (—110° to 500°F) and chemical inertness are desired.

Cementable TEFLON Tape, 5 mil. to 60 mil. in thickness is available in continuous rolls up to 12 in. wide. Sheets are also available ⅛-in. thick in sizes to 24 x 24 in.; ¼-in. thick in sizes to 48 x 48 in.

Now—if the problem says "TEFLON", price ceases to be a factor. Specify Cementable TEFLON Tape.

*du Pont Trademark

BELMONT **UNITED STATES GASKET CO.**

CAMDEN 1, NEW JERSEY

Name .....

5 MC Band-Width

10 MV per inch

PRECISION

PRESENTS THE NEW MODEL **ES-550**

High Sensitivity, Wide Band

5" OSCILLOSCOPE

For laboratory, industrial and technician. A rugged, dependable instrument for broad coverage of modern electronic oscillograph applications, INCLUDING COLOR TV. High sensitivity PLUS single, overall wide-band frequency response, and many other special performance features — at most sensible price.

★ **Push-Pull, Wide-Band Vertical Amplifier:** 10 MV/inch sensitivity. 2 Megohms, 22 mmfd. One DB from 10 cps. to 3.5 MC—3 DB at 5 MC.

★ **Direct Reading, Peak to Peak Voltage Calibrator**

★ **Vertical Pattern Reversal Switching Facility**

★ **Push-Pull, Wide-Range Horizontal Amplifier:** 100 MV/inch sensitivity. 2 Megohms, 25 mmfd. One DB from 10 cps. to 1.0 MC—3DB at 2 MC.

★ **Linear, Multi-vibrator Sweep Circuit:** 10 cycles to 100 KC. Amplified sweep retrace blanking.

★ **Amplified Auto-Sync Circuit**

★ **Four Way Sync. Selector Switch** provides for internal Negative, Internal Positive, External and Line Synchronization.

★ **"Z" Axis Input** for blanking, timing, marking.

★ **Built-in 60 cps Phasing and Blanking Controls.**

★ **All 4 Deflection Plates Available** directly (at rear), with full beam centering facilities.

★ **Tube Complement:** 12AV7 "V" Cathode Follower-Ampl. 6U8 "V" Ampl.-Phase Splitter. Two 6CL6 Push-Pull "V" Drivers. 6U8 "H" Cathode Follower-Ampl. 6C4 "H" Phase Splitter. Two 12BH7 Push-Pull "H" Drivers. 12AV7 Linear-Sweep. 6BH6 Auto-Sync. Ampl. 12AU7 Sweep Retrace Blanking Ampl. OA2 Voltage Regulator. 5V4 Low Voltage Rect. Two 1V2 High Voltage Rect. 5CP1/A CR Tube.

★ **High Contrast, Filter Type, Calibrating Screen**

★ **Fully Licensed** under AT&T and RCA patents.

Model ES-550 Deluxe: (Illustrated) In custom-styled, blue-grey ripple finished steel cabinet; 2 color satin-brushed aluminum panel and contrasting dark blue control knobs. Case Dimensions 8¼ x 14½ x 18½ inches. Complete with all tubes, including 5CP1/A CR tube. Comprehensive Instruction Manual.

Net Price $235.00

Model ES-550 Standard: Electrically identical to above but in standard black cabinet with black anodized aluminum panel. Case Dimensions 8¼ x 14½ x 18½ inches. Complete as above.

Net Price: $230.00

***PRECISION** Test Equipment is available and on display at leading electronic parts distributors. Write directly to factory for new 1956 catalog.*

***PRECISION** Apparatus Company, Inc.*

70-31 84th Street, Glendale 27, L. I., N. Y.

Export: 458 Broadway, New York 13, U. S. A.

Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

Want more information? Use post card on last page.

Rheem Mfg. Co. 281
Richardson Co. 291
Rotron Manufacturing Co., Inc. 206
Royal Metal Mfg. Co. 32A, 32B

Sams & Co., Inc., Howard W. 430
Sanders Associates, Inc. 438
Scintilla Div., Bendix Aviation Corp. 116
Scovill Mfg. Co. 264
Seeburg Corporation 79
Shallcross Mfg. Co. 282
Shasta, Div. Beckman Instruments Inc. 372
Sierra Electronic Corp. 246
Sigma Instruments, Inc. 320
Sola Electric Company 347
Sonex, Inc. 423
Sorensen & Co., Inc. 4
South Chester Corp. 34
Southern Electronics Corp. 327
Southwestern Industrial Electronics Co. 61
Spectrol Electronics Div. of Carrier Corp. 204
Sprague Electric Co. 11, 103
Stackpole Carbon Co. 75
Staedtler, Inc., J. S. 360
Standard Electric Time Co., The 78
Stevens Arnold, Inc. 384
Stewart Corp., F. W. 396
Stoddart Aircraft Radio, Co., Inc. 344, 408
Stromberg-Carlson Company 355, 426
Stupakoff Ceramic & Manufacturing Co., Div. of the Carborundum Co. 394, 395
Sun Tube Corp. 236
Superior Electric Co. 317
Superior Tube Co. 341
Switchcraft, Inc. 368
Sylvania Electric Products, Inc. 269, 325, 363
Syntronic Instruments, Inc. 424

Taylor Fibre Co. 313
Technicraft Laboratories, Inc. 254
Technology Instrument Corp. 294
Teiner Engineering Corp. 376
Tektronix, Inc. 345
Telex, Inc. 390
Tel-Instruments, Electronics Corp. 368
Tensitron, Inc. 446
Texas Instruments, Inc. 207
Tower Construction Co. 96
Transicoil Corp. 337
Transitron Electronic Corp. 99, 101
Transradio, Ltd. 398
Triplett Electrical Instrument Co. 88
Tru-Ohm, Div. of Model Engineering & Mfg. Co. 217
Tung-Sol Electric, Inc. 373

Ucinite Co., The 106
Union Switch & Signal, Div. of Westinghouse Air Brake Co. 392, 393
United Airlines 229
United States Gasket Co. 507
United Transformer Co. ..... 2nd Cover
Unitek Corp. 376
Universal Winding Company 255
U. S. Engineering Co., Inc. 210
U. S. Stoneware, Alite Div. 115

Varian Associates 60, 414
Veeder-Root, Inc. 333
Virginia Electric & Power Co. 248
Vitro Corp. of America 400
Vulcan Electric Co. 460

Waldes Kohinoor, Inc. 81
Waterman Products Co., Inc. 284
Waters Manufacturing, Inc. 412, 413
Wenco Manufacturing Co. 421
Western Gear Corp. 110
Weston Electrical Instrument Co. 411
Westinghouse Electric Corp. 48, 365, 433, 434, 435, 436
Wheelock Signals, Inc. 276
White Dental Mfg. Co., S. S. 239, 342
Worcester Pressed Steel Co. 353

MANUFACTURER'S REPRESENTATIVES 446

PROFESSIONAL SERVICES 445

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

SEARCHLIGHT ADVERTISING 489-502
ADVERTISERS INDEX 488

EMPLOYMENT OPPORTUNITIES..447-488
ADVERTISERS INDEX 487

This index is published as a service. Every care is taken to make it accurate, but ELECTRONICS assumes no responsibility for errors or omissions.

electronics

READER SERVICE SECTION

A method that provides readers with a . . .

"DIRECT-TO-THE-MANUFACTURER"

method of obtaining information on:

1. Products advertised in this issue
2. New Products and Literature covered in the editorial section of this issue

This direct method prevents loss of time in remailing your request from publication to manufacturer.

THESE POST CARDS ARE FOR YOUR USE

and

HERE IS WHAT YOU DO:

1. Fill in with ink or typewriter your name, company, address and title.

2. Then fill in the name of the specific product and the page number on which it appears.

3. Place a check mark in the box or boxes applicable to your needs.

4. Tear out the postcard on the perforated lines and address it to the manufacturer(s) whose products you are interested in. Place a stamp in the box indicated and drop into the mail.

THE MANUFACTURER WILL PROMPTLY SEE THAT YOU RECEIVE THE NECESSARY PRODUCT DATA OR THAT HIS REPRESENTATIVE CALLS UPON YOU, WHICHEVER YOU DESIRE.

If there is insufficient space on the postcard for describing your problem specifically, we suggest you write to the manufacturer, spelling out your requirements in detail. Be sure your filled in postcard accompanies your letter.

THIS SERVICE IS A CONVENIENCE FOR THE READERS OF ELECTRONICS.

Name .....

Company .....

Address .....

Title .....

Please send me further information on

(Product or Service) .....

As described in ad on page ..... of April 1956 Issue

or, Check: New Product | Literature | ..... on Page .....
(Name of Product or Literature)

☐ I want this information for my files

☐ I wish to see your representative

electronics

☐ Please contact me by telephone. Phone Number .....

Name .....

Company .....

Address .....

Title .....

Please send me further information on

(Product or Service) .....

As described in ad on page ..... of April 1956 Issue

or, Check: New Product | Literature | ..... on Page .....
(Name of Product or Literature)

☐ I want this information for my files

☐ I wish to see your representative

electronics

☐ Please contact me by telephone. Phone Number .....

Name .....

Company .....

Address .....

Title .....

Please send me further information on

(Product or Service) .....

As described in ad on page ..... of April 1956 Issue

or, Check: New Product | Literature | ..... on Page .....
(Name of Product or Literature)

☐ I want this information for my files

☐ I wish to see your representative

electronics

☐ Please contact me by telephone. Phone Number .....

Name .....

Company .....

Address .....

Title .....

Please send me further information on

(Product or Service) .....

As described in ad on page ..... of April 1956 Issue

or, Check: New Product | Literature | ..... on Page .....
(Name of Product or Literature)

☐ I want this information for my files

☐ I wish to see your representative

electronics

☐ Please contact me by telephone. Phone Number .....

Name .....

ELECTRONICS
April 1956

Place 3¢ Stamp Here

TO: _____

_____

_____

ELECTRONICS
April 1956

Place 3¢ Stamp Here

TO: _____

_____

_____

ELECTRONICS
April 1956

Place 3¢ Stamp Here

TO: _____

_____

_____

ELECTRONICS
April 1956

Place 3¢ Stamp Here

TO: _____

_____

_____

ELECTRONICS
April 1956

Place

To the Readers

of

electronics

A New Reader Service designed to provide prompt response

You, as a reader, may never have thought specifically of the viewpoint of the advertisers whose informative and up-to-date product news reaches you through the advertising pages of ELECTRONICS.

They are VITALLY interested in you and your needs. You and thousands like you constitute the market and without you they cannot continue to present their product story; indeed, they cannot remain in business.

These manufacturers whose products and services are shown in this issue welcome your inquiries and your desire for more information.

If your requirements are complicated and you require more space, we suggest that you write directly to the manufacturer, stating your problem in detail and asking for specific information or assistance. Be sure to include the postcard with your detailed request in order that your inquiry be given prompt and expeditious attention. Make certain that you specify which PRODUCT you are interested in if more than one appears in the advertisement.

electronics

READER SERVICE SECTION

A method that provides readers with a . . .

"DIRECT-TO-THE-MANUFACTURER"

method of obtaining information on:

1. Products advertised in this issue
2. New Products and Literature covered in the editorial section of this issue

This direct method prevents loss of time in remailing your request from publication to manufacturer.

THESE POST CARDS ARE FOR YOUR USE

and

HERE IS WHAT YOU DO:

1. Fill in with ink or typewriter your name, company, address and title.

2. Then fill in the name of the specific product and the page number on which it appears.

3. Place a check mark in the box or boxes applicable to your needs.

4. Tear out the postcard on the perforated lines and address it to the manufacturer(s) whose products you are interested in. Place a stamp in the box indicated and drop into the mail.

THE MANUFACTURER WILL PROMPTLY SEE THAT YOU RECEIVE THE NECESSARY PRODUCT DATA OR THAT HIS REPRESENTATIVE CALLS UPON YOU, WHICHEVER YOU DESIRE.

If there is insufficient space on the postcard for describing your problem specifically, we suggest you write to the manufacturer, spelling out your requirements in detail. Be sure your filled in postcard accompanies your letter.

THIS SERVICE IS A CONVENIENCE FOR THE READERS OF ELECTRONICS.

☐ Please contact me by telephone. Phone Number.....

Name .....

Company .....

Address .....

Title .....

Please send me further information on

(Product or Service).....

As described in ad on page ..... of April 1956 Issue

or, Check

New Product	☐
Literature	☐

..... on Page .....
(Name of Product or Literature)

☐ I want this information for my files

☐ I wish to see your representative

electronics

☐ Please contact me by telephone. Phone Number.....

Name .....

Company .....

Address .....

Title .....

Please send me further information on

(Product or Service).....

As described in ad on page ..... of April 1956 Issue

or, Check

New Product	☐
Literature	☐

..... on Page .....
(Name of Product or Literature)

☐ I want this information for my files

☐ I wish to see your representative

electronics

☐ Please contact me by telephone. Phone Number.....

Name .....

Company .....

Address .....

Title .....

Please send me further information on

(Product or Service).....

As described in ad on page ..... of April 1956 Issue

or, Check

New Product	☐
Literature	☐

..... on Page .....
(Name of Product or Literature)

☐ I want this information for my files

☐ I wish to see your representative

electronics

☐ Please contact me by telephone. Phone Number.....

Name .....

Company .....

Address .....

Title .....

Please send me further information on

(Product or Service).....

As described in ad on page ..... of April 1956 Issue

or, Check

New Product	☐
Literature	☐

..... on Page .....
(Name of Product or Literature)

☐ I want this information for my files

☐ I wish to see your representative

electronics

☐ Please contact me by telephone. Phone Number.....

ELECTRONICS
April 1956

Place 3¢ Stamp Here

TO: _____

_____

_____

ELECTRONICS
April 1956

Place 3¢ Stamp Here

TO: _____

_____

_____

ELECTRONICS
April 1956

Place 3¢ Stamp Here

TO: _____

_____

_____

ELECTRONICS
April 1956

Place 3¢ Stamp Here

TO: _____

_____

_____

For PRODUCTS and SERVICES

not specifically advertised

or described in the issue

of

Electronics

Consult your

1955-1956 ELECTRONICS BUYERS' GUIDE

or

Write to:

Reader Service Department

Electronics

330 West 42nd Street

New York 36, N. Y.

☐ Please contact me by telephone. Phone Number.....

PRODUCTS OF WORLD-FAMOUS

DAVEN

CREATIVE-ENGINEERING

TYPE T-330

DAVEN ATTENUATORS

Exclusive Features:

1. **"Knee-Action" Blade**
   - Tamper proof
   - Uniform contact pressure and low contact resistance over the life of every unit.
   - Each rotor blade individually supported to give positive contact in operation under all types of conditions.
2. **Brass Case of 2-Piece Construction**
   - Greatly reduces clearance space required for removal of cover in rear of unit.
3. **"Lock-Tite" Dust Cover**
   - Held by positive, bayonet-type lock which prevents cover from falling off under stress of vibration.
4. **Enclosed Roller-Type Detent Mechanism**
   - For extra long life and positive indexing.
   - Addition of detent does not increase depth of unit.
5. **Low-Loss Molded Terminal Board**
   - For high resistance to leakage.
6. **Rigidly Supported Resistor Strips**
   - With air insulation.

YEARS AHEAD, CREATIVE-ENGINEERING has always characterized Daven's efforts in the production of electronic components and equipment.

The unit illustrated above is only one in a complete line of Daven's world-famous attenuators. Because this Company has pioneered and created so many worth-while improvements in units of this type, you can do no better than to specify Daven Attenuators.

Daven's skilled staff of specialist-engineers is at your "beck and call" to help with your problems in the selection of the right attenuators for the equipment you are designing.

Write for complete catalog data.

THE DAVEN CO.

526 West Mt. Pleasant Avenue
Livingston, New Jersey

GREATLY EXPANDED PRODUCTION FACILITIES ENABLE DAVEN TO MAKE DELIVERY FROM STOCK ON A LARGE NUMBER OF STANDARD ATTENUATOR TYPES.

NEW HORIZONTAL AMPLIFIER TUBE

with POWER to SPARE!

. . . RCA-6DQ6-A runs "cool" in today's deflection systems . . . has power-to-spare for tomorrow's wide-angle designs.

Another outstanding example of RCA's progressive design-engineering in the field of electron-tubes, RCA-6DQ6-A is designed to meet all the requirements for a high-efficiency horizontal amplifier tube in today's TV receivers. And, it has the necessary power-to-spare for efficient operation in tomorrow's circuits which may require *horizontal deflection in excess of 90°*.

RCA-6DQ6-A, and its series-string equivalent RCA-12DQ6-A, are glass-octal high-perveance beam-power tubes having substantially higher ratings than the 6DQ6 and 12DQ6 for dc plate voltage (including boost), dc grid-No. 2 voltage, average cathode current, and grid-No. 2 input, plus a high operating ratio of plate current to grid-No. 2 current. Internal structural mounts are so designed as to give maximum heat dissipation, prevent "hot spots" on the plate, allow "cooler" operation of the grids.

Gain the advantages now offered to your designs by specifying this new RCA tube—longer in-the-set operating life (it runs "cooler")—brighter pictures (higher efficiency, greater power-handling capability).

Maximum Ratings	6DQ6, 12DQ6	6DQ6-A, 12DQ6-A
Plate Volts (incl. boost)	550	700
Grid-No. 2 Volts	175	200
Av. Cath. Current	120 ma	140 ma
Grid #2 Input	2.5 w	3 w

EAST: HUmboldt 5-3900
744 Broad Street
Newark 1, N. J.

MIDWEST: WHitehall 4-2900
Suite 1181,
Merchandise Mart Plaza
Chicago 54, Ill.

WEST: RAymond 3-8361
6355 East Washington Blvd.
Los Angeles 22, Calif.

For sales information contact the RCA Office nearest you. For technical data, write RCA, Commercial Engineering, Section D190, Harrison, N. J.

RADIO CORPORATION of AMERICA
ELECTRON TUBES — HARRISON, N. J.